7 Data Extensions

Several BASINS extensions have been developed to assist with data management. The data management tools are used to update existing data or to add additional local or regional data to supplement or replace BASINS data products. The comprehensive data products included in BASINS were developed based on nationally available information and are suited for large-scale assessments. When dealing with localized small-basin analysis, however, higher-resolution data might be necessary to effectively capture the site-specific feature variability. The BASINS Data Extensions are described below.

- *Theme Manager*:
- *Import BASINS Data*: This tool is used to import additional data sets and to prepare the data to make them compatible with BASINS GIS functions and models. The *Import* tool is currently designed to function on four data types watershed boundaries, land use, Reach File Version 3, and Digital Elevation Model (DEM).
- *NHD Download Tool*: This tool gives the user the ability to download a National Hydrographic Dataset (NHD) reach file directly from the USGS NHD website and import the NHD reach file theme in the BASINS project, preparing the data to work properly with BASINS GIS functions and models.
- *Grid Projector*:
- *GenScn*: This tool facilitates the display and interpretation of timeseries data associated with model applications. In BASINS, GenScn serves as a postprocessor for both the HSPF and SWAT models.
- *WDMUtil*: This tool is used to manage Watershed Data Management (WDM) files, which are used to store input and output timeseries data for the HSPF model.

7.1 Theme Manager

Purpose

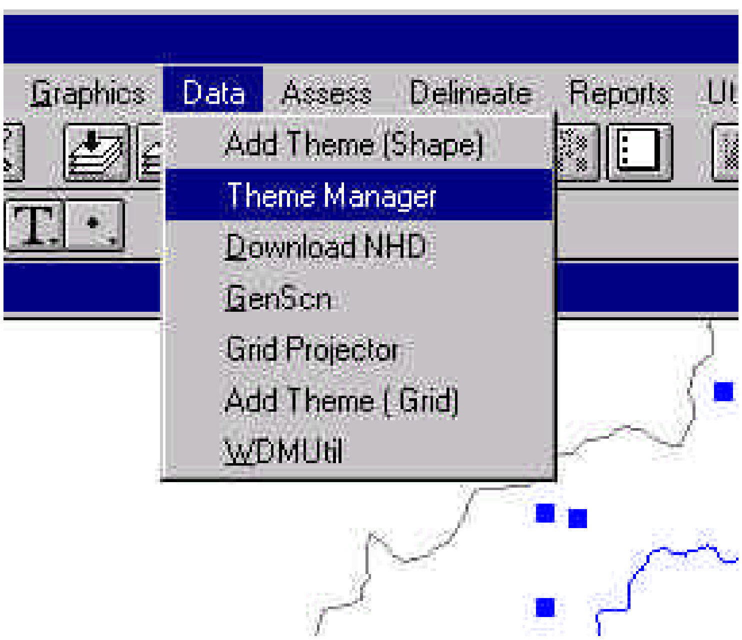
The BASINS *Theme Manager* tool gives the user the ability to import auxilliary BASINS themes. A newly built BASINS Project Builder does not include by default all available themes in a BASINS data set. These themes are called auxilliary BASINS themes since they are not required by any of the BASINS tools or models.

Before you Get Started

First, verify that the Theme Manager extension is active in your BASINS project by typing Ctrl+B from the BASINS view and selecting the **Data** item from the **Extension Categories** dropdown list. The Theme Manager entry in the **Basins Extensions** list should be visible and selected. If the Theme Manager is not selected (checked), click on it to select it.

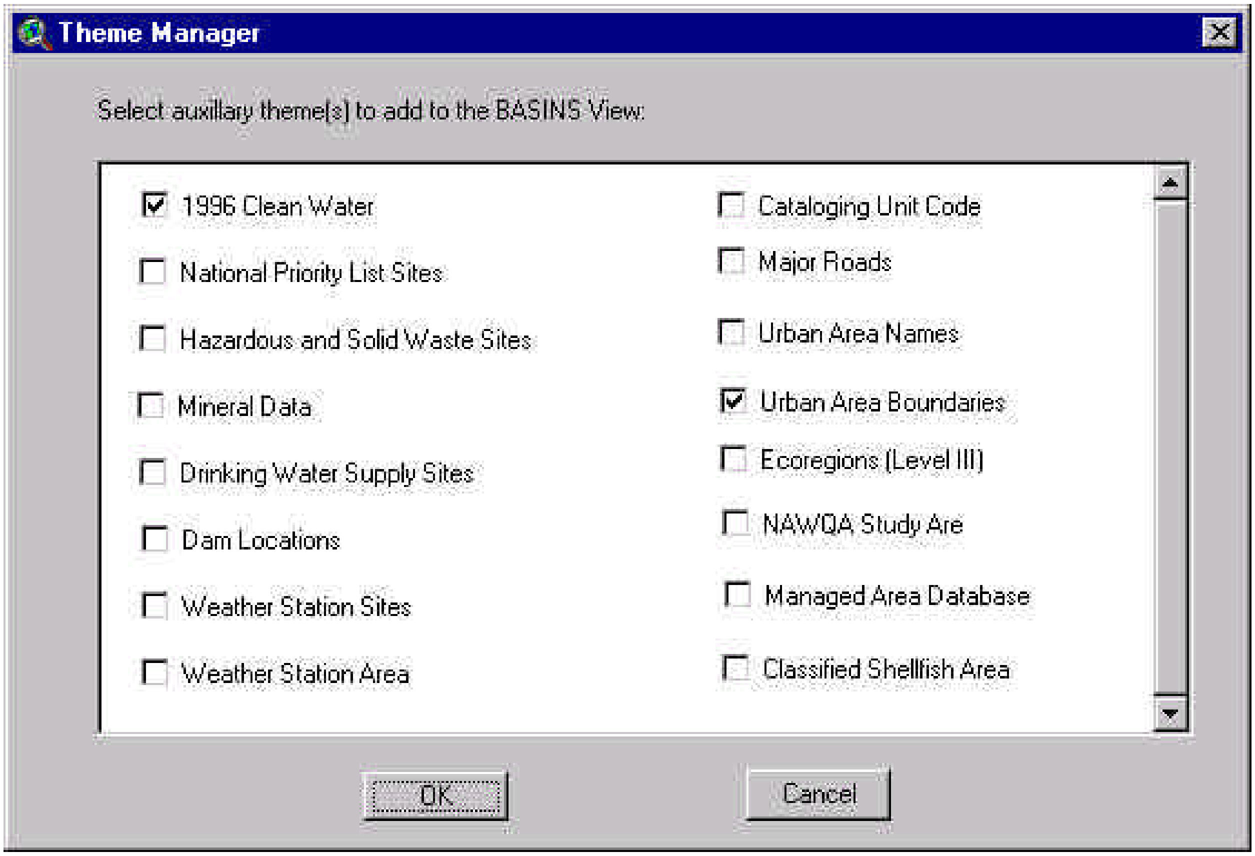
Application

The *Theme Manager* is accessed through the *Data* menu. Click on the Data menu and select the Theme Manager menu item.



Screen 7.1.1

The Theme Manager will appear as a new window.



Screen 7.1.2

Select the themes to be added to the BASINS View. Themes may be selected or unselected using the check boxes next to each theme name. Click *OK* to load the selected themes.

7.2 Import BASINS Data

Purpose

The BASINS *Import* tool gives the user the ability to import additional data sets and prepares the data to work properly with BASINS GIS functions and models. There are two versions of this tool, one for importing shape themes and the other for adding grid themes.

Application

When conducting a watershed assessment using BASINS, the user will often want to add additional local or regional data to supplement or replace BASINS data products. The comprehensive data products included in BASINS were developed based on nationally available information and are suited for large-scale assessments. When dealing with localized small-basin analysis, however, higher-resolution data may be necessary to effectively capture the site-specific feature variability. The BASINS system is designed to provide a flexible GIS framework that allows users to easily integrate local environmental data to supplement or replace the national data products supplied with the program.

The BASIN *Import* tool functions like the standard “Add Theme” tool in ArcView; however, it performs additional functions to prepare the data for use with BASINS GIS functions and models. The BASINS *Import* tool is currently designed to import five data types watershed boundaries, land use (shape and grid) data, Reach File Version 3, National Hydrography Dataset (NHD) and Digital Elevation Model (DEM) (shape and grid) data. As summarized in Table 7.2.1, the five data types must contain a number of required data attributes. Other data layers can be imported as a standard ArcView coverage. *To import a new data layer into BASINS, the data layer must have the same projection and datum (NAD83) as the data in the BASINS project*. The projection parameters for the project were selected during the initial BASINS data extraction and can be determined by using the “Lookup Project Parameter” submenu under the *Reports* menu. The BASINS *Import* tool allows the user to project the new data layer, if needed.

Table 7.2.1 **Required Data Attributes**

Data Type	Type of Coverage Required	Required Field and Its Attributes	Other Restrictions
Watershed Boundaries	Polygon	No attributes required	All watershed polygons must overlay an RF1 or RF3 line segment
Land Use	Polygon	Land use code field Land use area in m2 Land use description field	User-imported land uses are currently configured to work only with *HSPF* and cannot be used with the Land Use Report generator
Land Use	Grid	No attributes required	This function is designed to work with landuse grid data such as MRLC data.
Digital Elevation Model (DEM)	Polygon	BASINS DEM data	This function is designed to work with the DEM data provided with BASINS.
Digital Elevation Model (DEM)	Grid	No attributes required	This function is designed to work with the DEM (grid) data provided with BASINS. However, it can also be used to add higher resolution DEM data such as the 24K DEM.
NHD Reach File	Line Coverage	BASINS NHD Data	This function is designed to work with the NHD data. The NHD download tool can be used to download the NHD dataset from the USGS ftp site.
Reach File, V3 (RF3)	Line Coverage	BASINS RF3 data	This function is designed to work with the RF3 data provided with BASINS.

Key Procedures

- Select *Add Theme* from the View menu. This is the version for the adding shape themes.
- Select one of the following from the dialog message box
  - BASINS Watershed
  - BASINS Land Use

- BASINS Reach File V3
- NHD Reach File
- BASINS DEM (polygon)

- - Other (This option corresponds to the standard "Add Theme" function in ArcView.)
- Select the shape file to be imported

Detailed Operations

Importing Watershed Data

Subwatershed boundaries delineated within a cataloging unit(s) are often required for small-basin analysis. Users can import their own subwatershed themes using the BASINS *Import* tool. The *Import* tool assigns each subwatershed a unique identification number that is used for BASINS GIS functions and modeling.

1. Select *Add Theme* from the View menu or use the *Import* button.

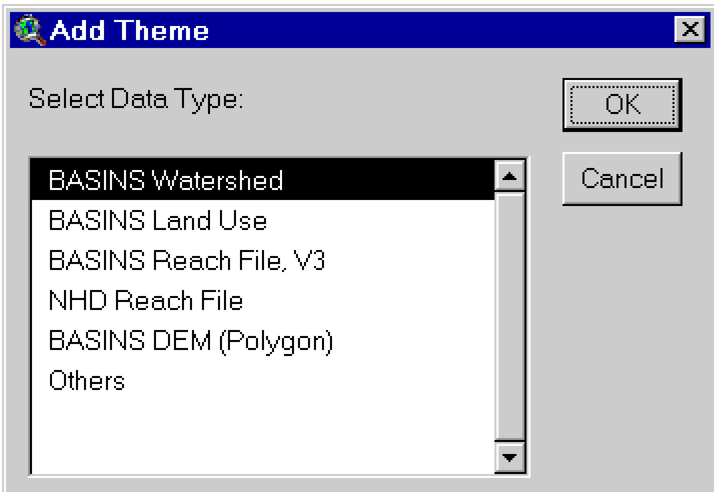
   Note: Make sure that the *Add theme* extension under the *Data*extension category is turned on. This extension is loaded by default when the project is built.

2. Select "BASINS Watershed" from the data type message box (Screen 7.2.1).

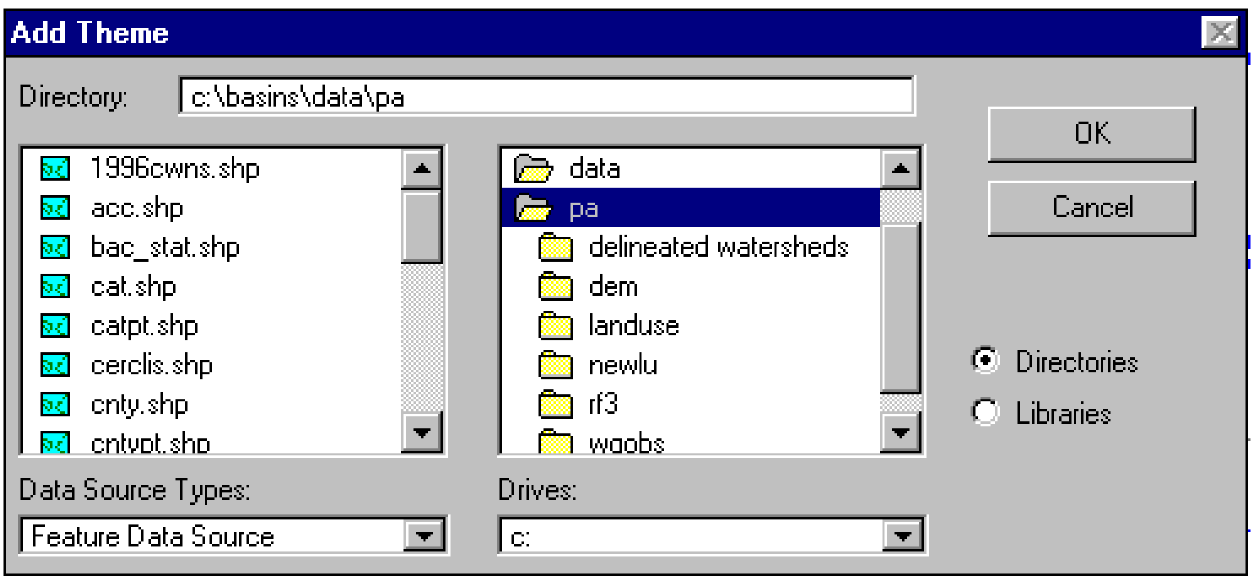
3. Select the shape file to be imported from BASINS\data\&ltproject_name&gt\watershed folder (Screen 7.2.2).

4. A dialog box will provide an option to project the data theme to be imported. If the data are not in the same map projection as the BASINS project, select *OK* to project the data. Refer to Section 4.2, *Data Extraction*, for an introduction to map projections.

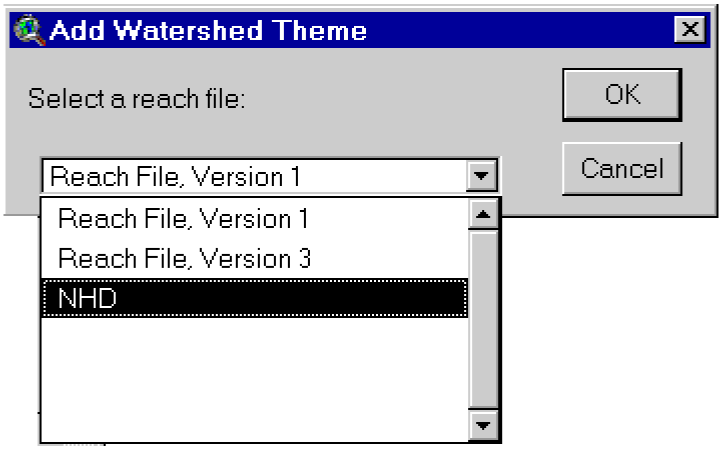
5. The final dialog will prompt you to select a reach file (Screen 7.2.3). Select "Reach File, Version 1"or "Reach File, Version 3" or NHD Reach File depending on the stream network to be used for *HSPF* modeling. A unique ID will be assigned to each subwatershed based on the RF1 or RF3 or NHD segment that it contains. This unique subwatershed ID is used for watershed characterization report functions and modeling.



Screen 7.2.1



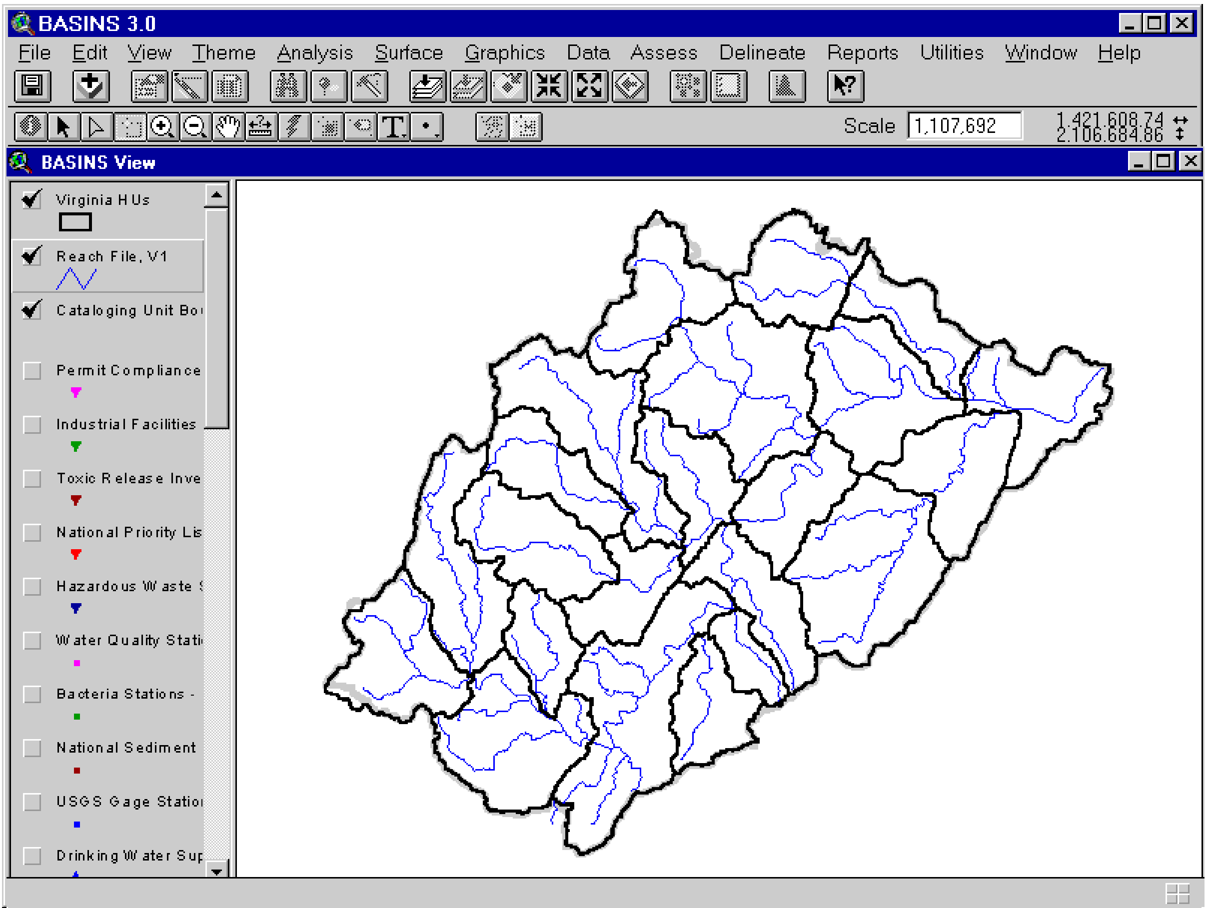
Screen 7.2.2



Screen 7.2.3

Example:

Hydrologic unit boundaries delineated by state or county agencies can be imported directly into BASINS and used with BASINS tools. In this example hydrologic unit boundaries delineated by the Virginia Division of Soil and Water Conservation were reprojected and imported into a BASINS project file for use with *HSPF* (Screen 7.2.4).



Screen 7.2.4

Importing Land Use Data

The USGS landuse GIRAS themes that are distributed with BASINS or other landuse layers must be imported using the BASINS land use *Import* tool before they can be used for landuse reclassification and modeling. The following steps are used to prepare the new data set for future land use reclassification and modeling. Refer to Section 7.2 of the manual for additional information on land use reclassification.

1. Select *Add Theme* from the View Menu or use the *Import* button.

Tip: Land use data imported by a user can be used by *HSPF* but is not available for the Land Use Distribution Report function.

2. Select “BASINS Land Use” from the data type dialog box (Screen 7.2.1).

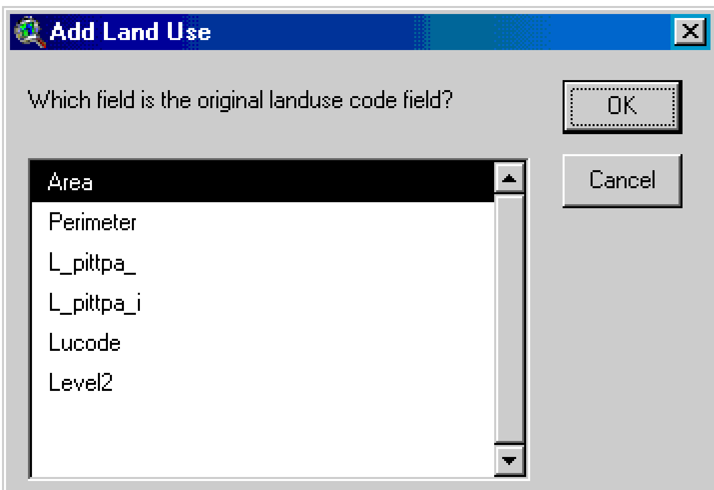
3. Select land use type.

4. Select the land use file name to be imported.

5. A dialog box will provide an option to project the data theme to be imported. If the data are not in the same map projection as the BASINS project, click *OK* to project the data. Refer to section 4.2, *Data Extraction*, for an introduction to map projections.

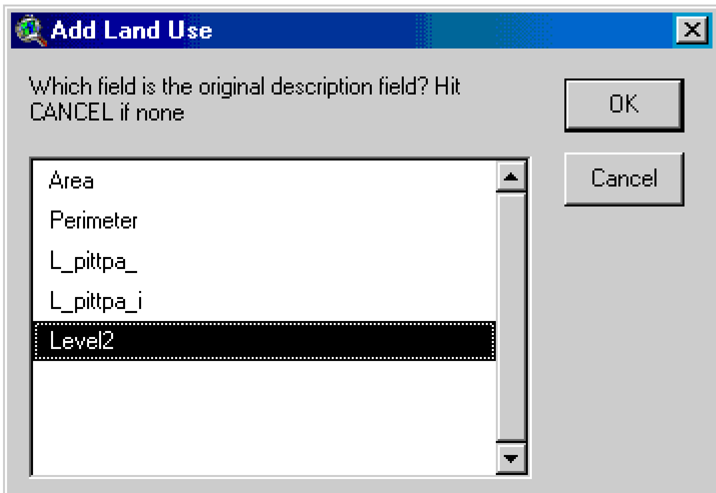
6. If the land use type selected is USGS GIRAS (step 3), the land use is immediately added into the project using predefined fixed settings and legends. If the landuse type selected is "Other", a series of windows will follow prompting the user to specify names of existing land use code and description fields. Declaration of these new fields is required to run *HSPF* and to reclassify land uses.

7. A message box will prompt you for the original land use code field. Select the land use code field name from the list and click *OK* (Screen 7.2.5).

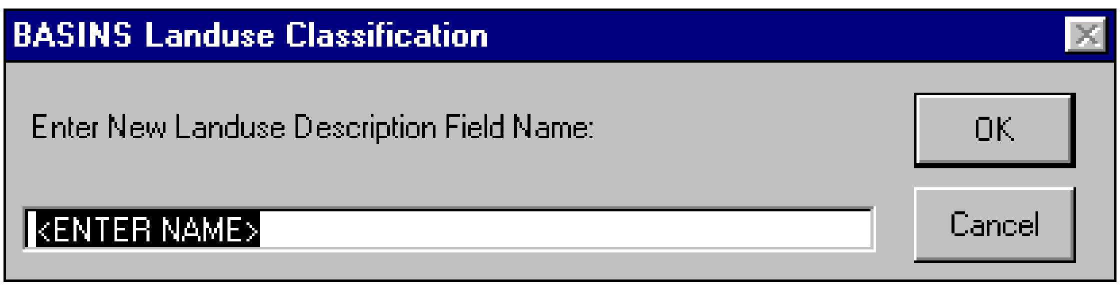


Screen 7.2.5

8. Select the existing land use description field and click *OK* (Screen 7.2.6). The descriptive field contains the name of the land use classification, such as residential or deciduous forest. If the new land use data do not contain a descriptive field, click *Cancel* to skip this step. Otherwise, enter a new land use description field name and click *OK* (Screen 7.2.7).



Screen 7.2.6



Screen 7.2.7

9. The last screen prompts you to enter a land use group number. If the land use is a single tile, click *Cancel*. The group number is used to identify tiles that belong to the same land use data layer.

10. The new land use theme is added to the BASINS View; however, it is unclassified. The new land use can be classified using the legend editor. Select the *Load* button within the legend editor to load default land use legends.

Importing Reach File Version 3 Data

The Reach File, Version 3 *Import* tool assigns a unique name to the theme and creates a default legend. This tool is designed to import Reach File Version 3 data that were extracted from the BASINS CD or web archive. These data are already in the proper projection and datum. Extracted Reach File data are located in a folder named "RF3" under the project data directory. The reach files are grouped by cataloging numbers.

1. Select *Add* Theme from the View menu or use the *Import* button.

2. Select "BASINS Reach File V3" from the data type dialog box (Screen 7.2.1).

3. Select the shape file to be imported from the BASINS\data\&ltproject_name&gt\rf3 folder (Screen 7.2.2).

Importing Digital Elevation Model (DEM) Coverages

The DEM *Import* tool assigns a unique theme name to the coverage and builds a default DEM legend to display the data. DEM data that were extracted from the BASINS CD or web archive can be directly imported into the BASINS View using this tool. These data are already in the proper projection and datum. DEM data extracted from the BASINS CD are located in a folder named “DEM” in the project data directory.

1. Select *Add* Theme from the View menu or use the *Add Theme* button.

2. Select “BASINS DEM (Polygon)” from the data type dialog box (Screen 7.2.1).

3. Select the shape file to be imported from the BASINS\data\&ltproject_name&gt\dem folder (Screen 7.2.2).

Importing National Hydrography Dataset

The NHD import tool adds the NHD shape theme in a specific format required by the delineation tools. NHD is correctly formatted and can be optimally added into the BASINS project through the NHD Download Tool (see section 7.3). In case when the user did not choose to add the NHD reach files into the project during download, the user has the option to use the NHD import tool to add the NHD reach files at a later date.

1. Select *Add* Theme from the View menu or use the *Import* button.

2. Select “NHD Reach File” from the data type dialog box (Screen 7.2.1).

3. Select the shape file to be imported from the BASINS\data\&ltproject_name&gt\nhd folder (Screen 7.2.2).

TUTORIAL:

Import the NHD Reach File O5010007, Reach File Version 3 theme O5010007 and the DEM theme 05010007 from the tutorial directory.

7.3 NHD Download Tool

Purpose

The BASINS NHD Download tool gives the user the ability to download the required National Hydrographic Dataset (NHD) reach file directly from the USGS NHD website and import the NHD reach file theme in the BASINS project, preparing the data to work properly with BASINS GIS functions and models.

Application

When conducting a watershed assessment using BASINS, the user may want to add the NHD reach file data to supplement the EPA Reach File Version 1(RF1) and Reach File Version 3(RF3) data within BASINS. The NHD is based upon the content of USGS Digital Line Graph (DLG) hydrography data integrated with reach-related information from the RF3. The NHD dataset incorporates the RF3 and DLG and is greatly expanded and refined.

The BASINS **NHD Download** tool functions like the standard "Add Theme" tool in ArcView; however, it performs additional functions to prepare the data for use with BASINS GIS functions and models. The data is seamlessly downloaded from the USGS NHD site, extracted and processed to be added to the arcview project.

Key Procedures

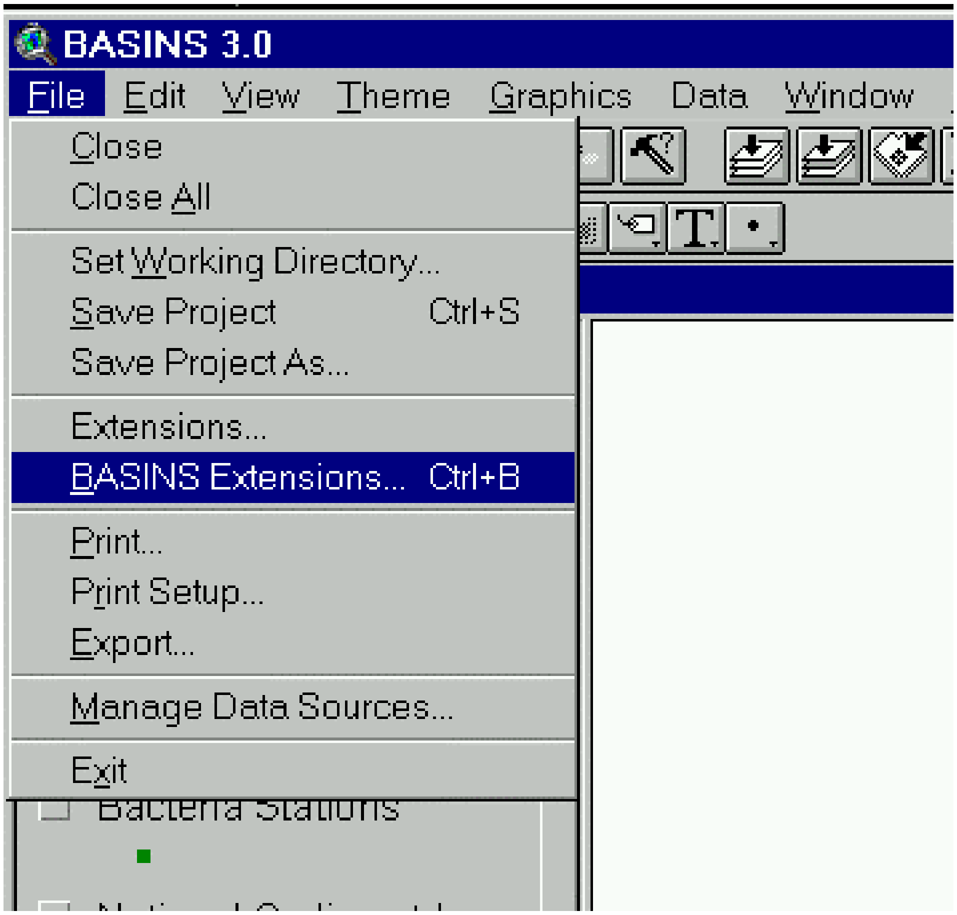
- Select BASINS Extensions from the File menu
- Select Data under the Extension Category and check the NHD *Import* Tool as the BASINS extension
- Make the Cataloging Unit Boundaries theme active and select the cataloging unit
- Select Download NHD from the Data menu
- Select next under the Import Message Box to confirm the selection
- Change the temporary and destination folder if required and select next again
- Select *Yes* to add the NHD dataset to the view

Detailed Operations

Importing NHD Data

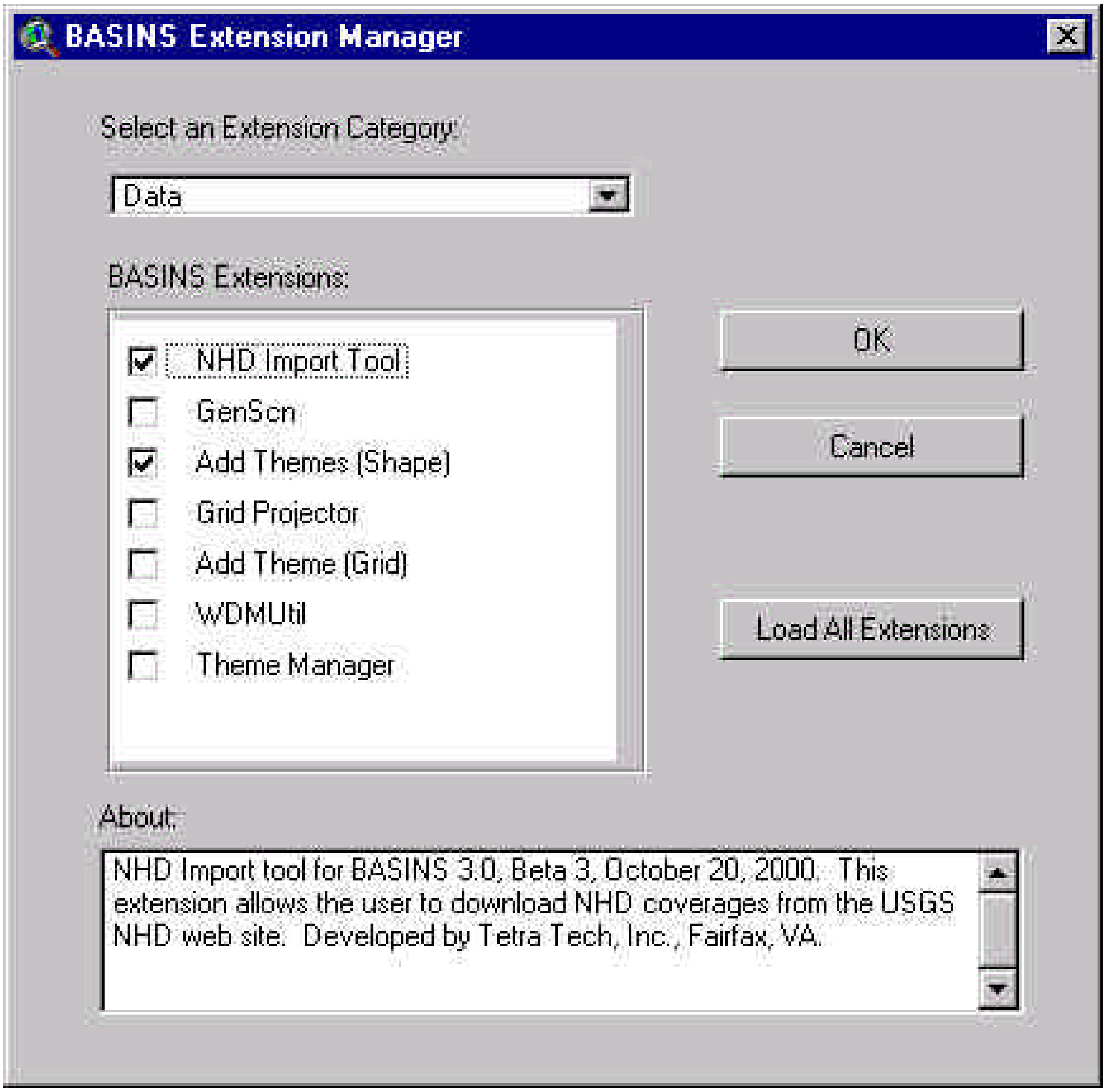
NHD data can be directly downloaded from the USGS NHD site and added to the current view using BASINS NHD download tool.

1. With BASINS View active (Screen 7.3.1), select the Basins Extensions... menu under the File menu.



Screen 7.3.1

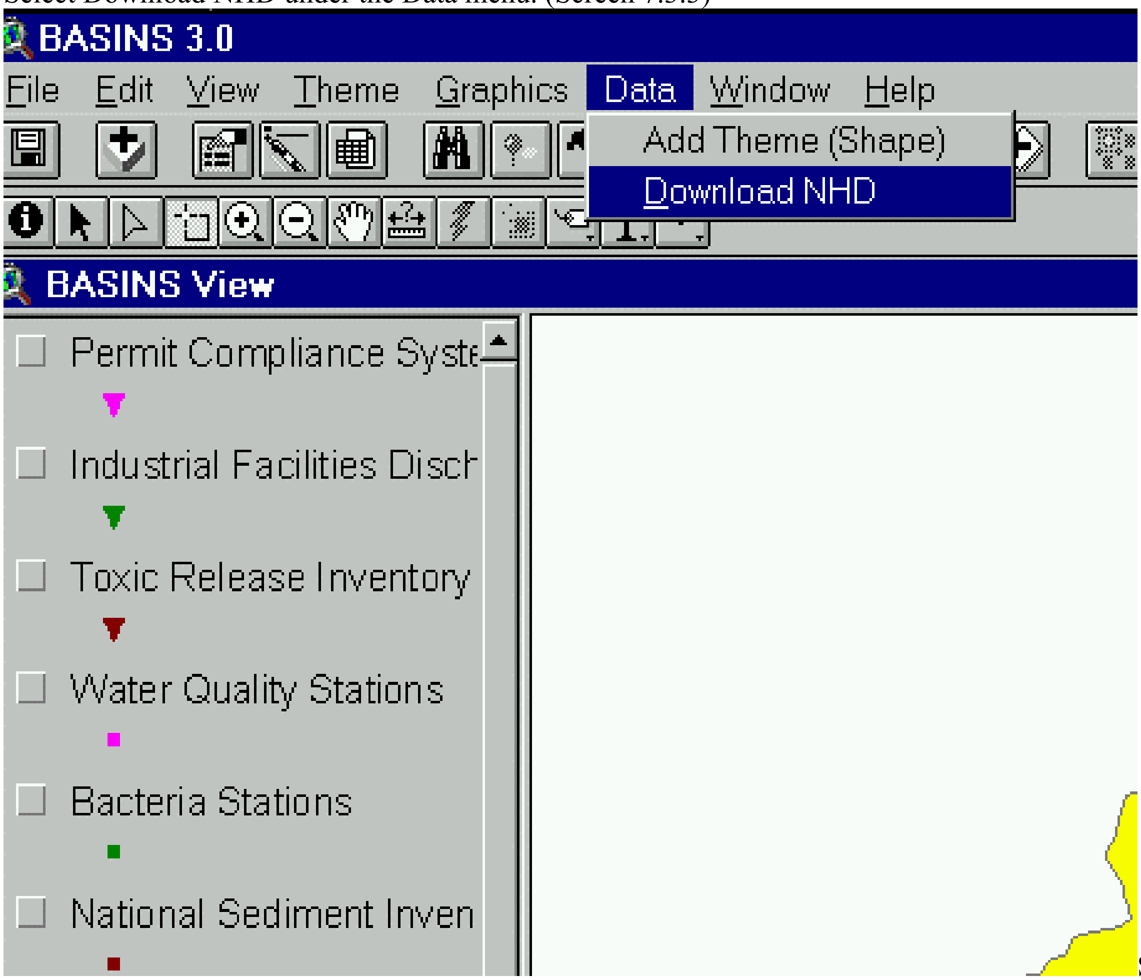
2. A “BASINS Extension Manager” dialog box will open. Select “Data” under “Select Extension Category”. Click NHD Download Tool as the BASINS extension. Note a small description of the extension at the bottom of the dialog box. Click on *OK* when done. This adds the Download NHD menu item to the Data menu.(Screen 7.3.2)



Screen 7.3.2

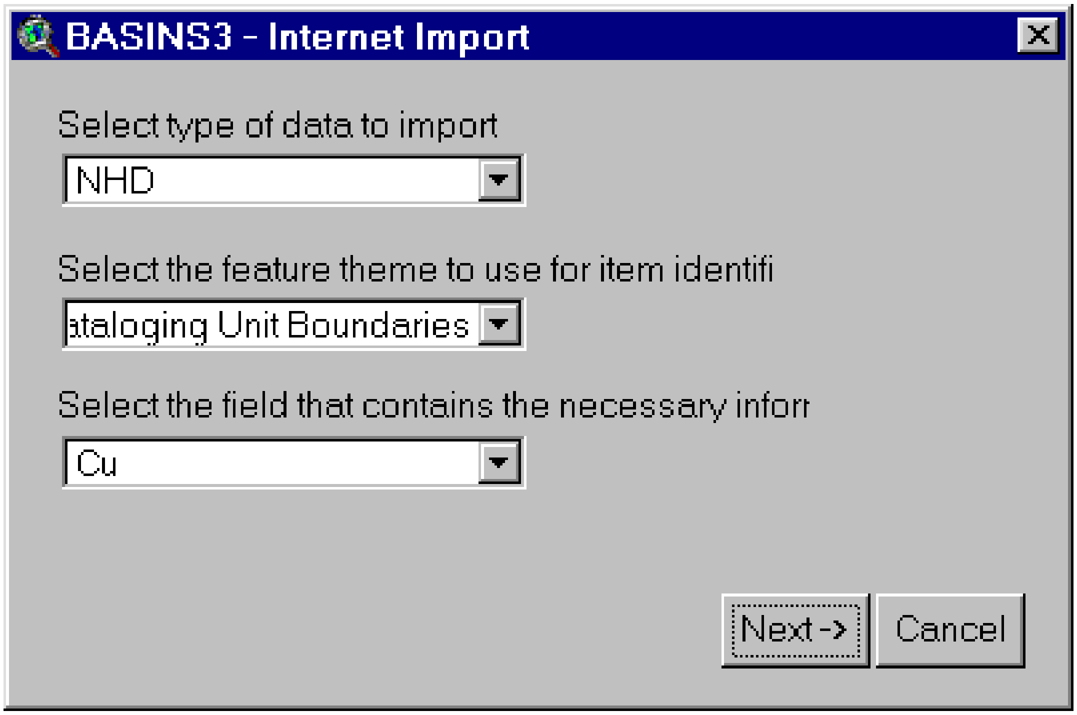
3. Select the *Cataloging Unit Boundary* theme and make it active. Select the area of interest in the watershed. You can use the *Select Feature tool* button or use the *Select by Theme* option under the Theme menu.

4. Select Download NHD under the Data menu. (Screen 7.3.3)



Screen 7.3.3

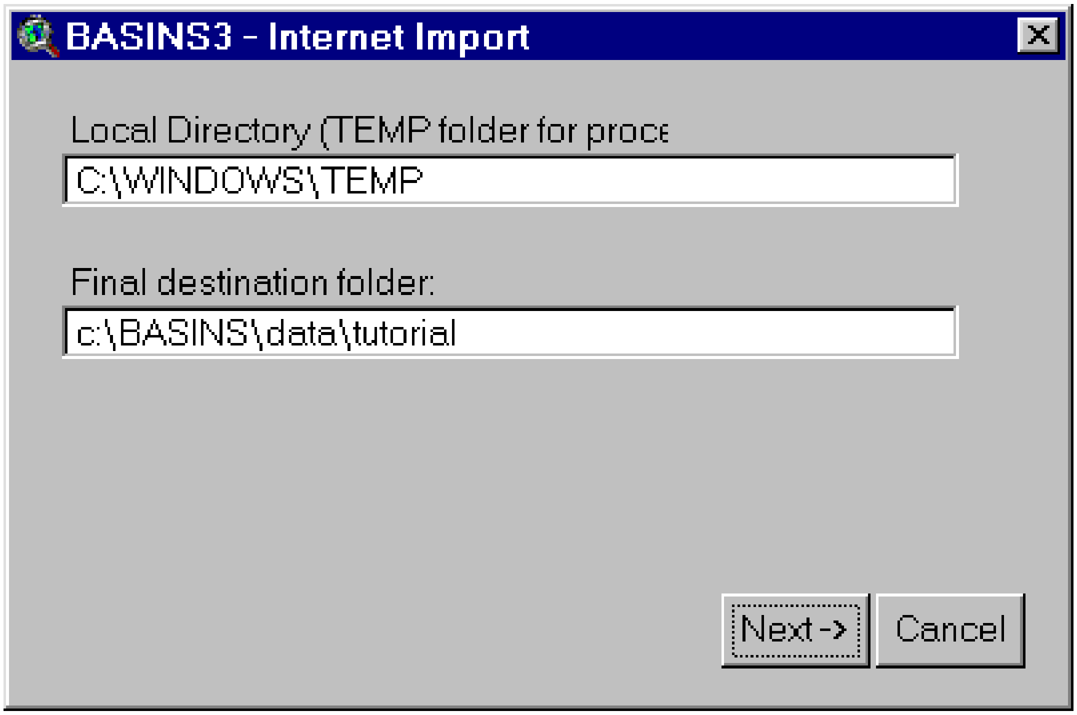
5. An Internet Import Dialog box shows up. In the Import Dialog box select “NHD” as the type of data to import, “Cataloging Unit Boundaries” as the feature theme to use for item identification and “Cu” as the field that contains the necessary information for downloading the dataset. (Screen 7.3.4)



Screen 7.3.4

6. Select Next when done.

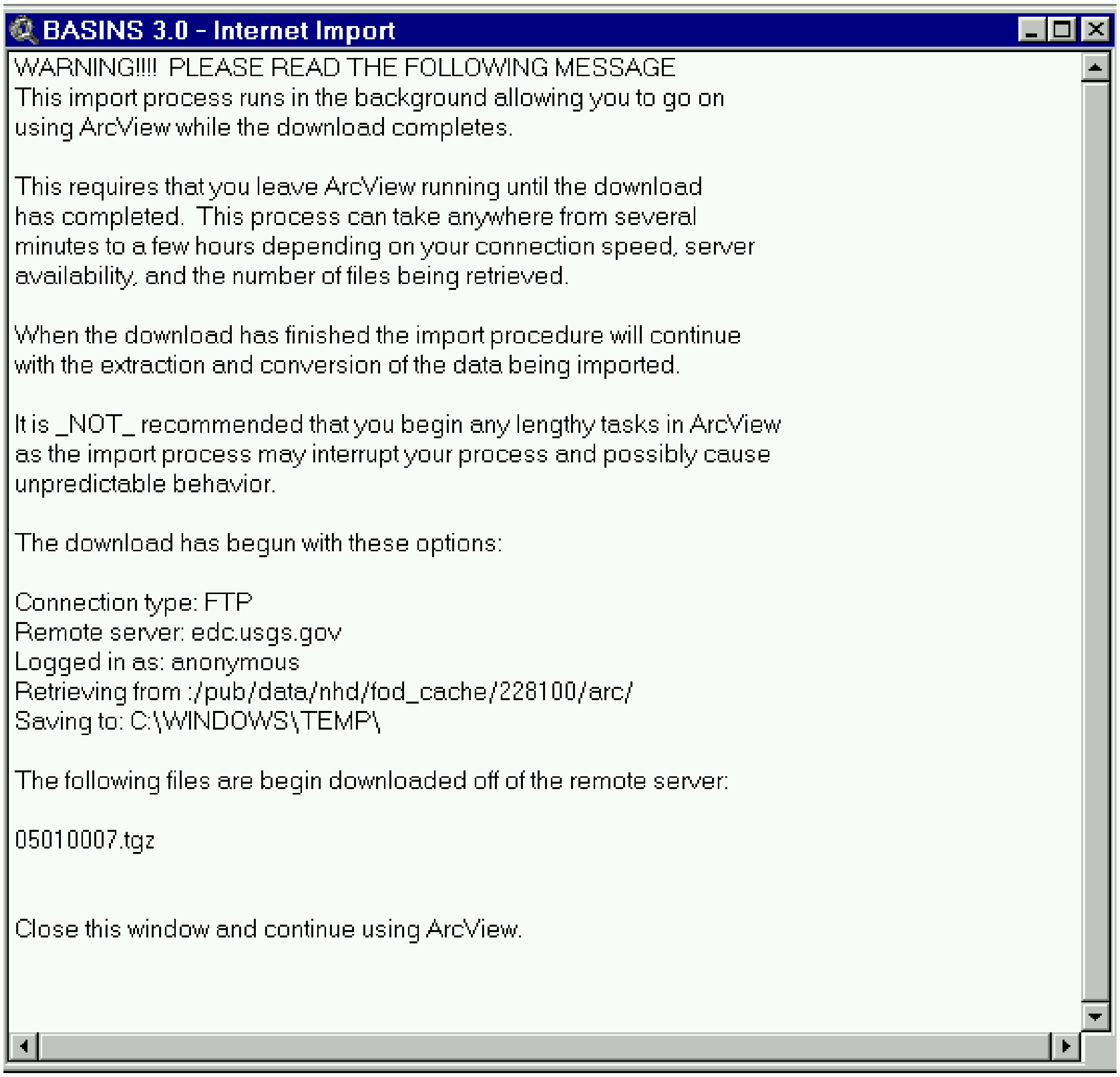
7. Upon selecting Next, the dialog will prompt the user to specify the local directory and the final destination directory path. The local directory is a temporary directory where the processing of the downloaded dataset is done. (Screen 7.3.5)



Screen 7.3.5

8. Select Next when done.

9. The dataset will start downloading in the background via a ftp session with the USGS NHD site. The user can continue working on other tasks in ArcView while the data is downloading. A window with a message will pop up (Screen 7.3.6). This message contains important information about using ArcView while the data is being downloaded. Click on the “X” button on the top right hand corner to remove this window after you finish reading the message.

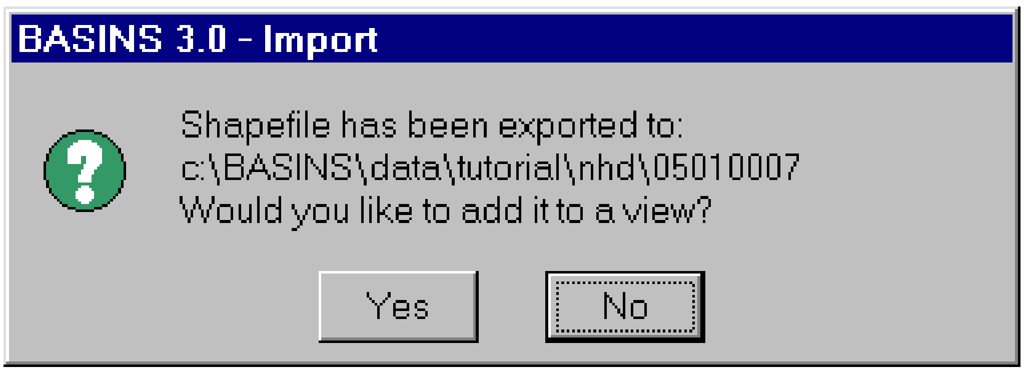


Screen 7.3.6

10. Upon finishing downloading a message box will show up stating that the download is complete (Screen 7.3.7). Click on *OK* to start the extraction and processing of the data.

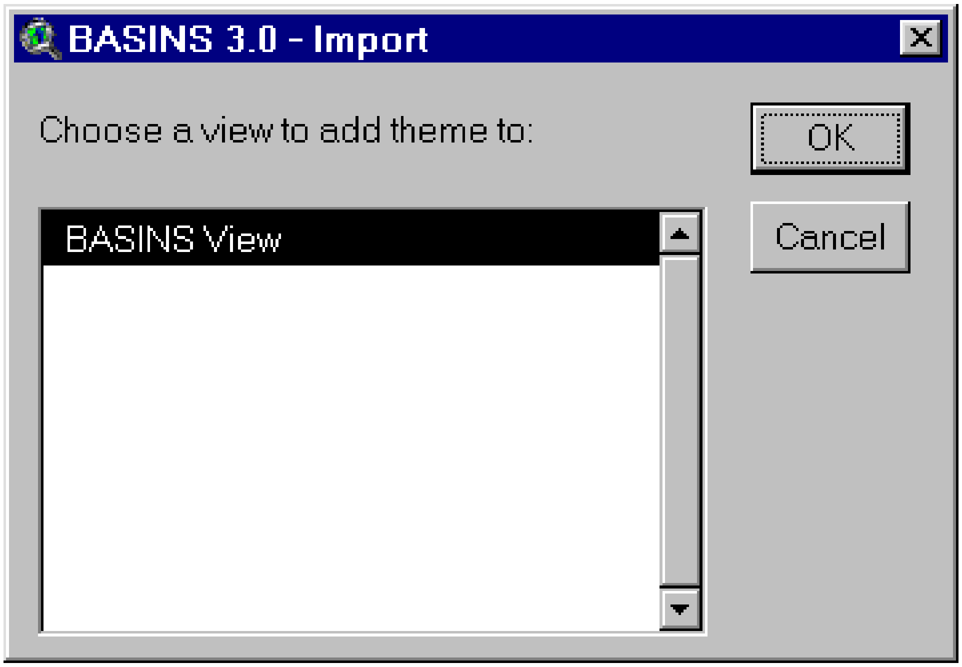
Screen 7.3.7

11. Upon completion of the extraction and processing of the data a message box will pop up. Click on *Yes* to add the NHD dataset to a view (Screen 7.3.8).ibw



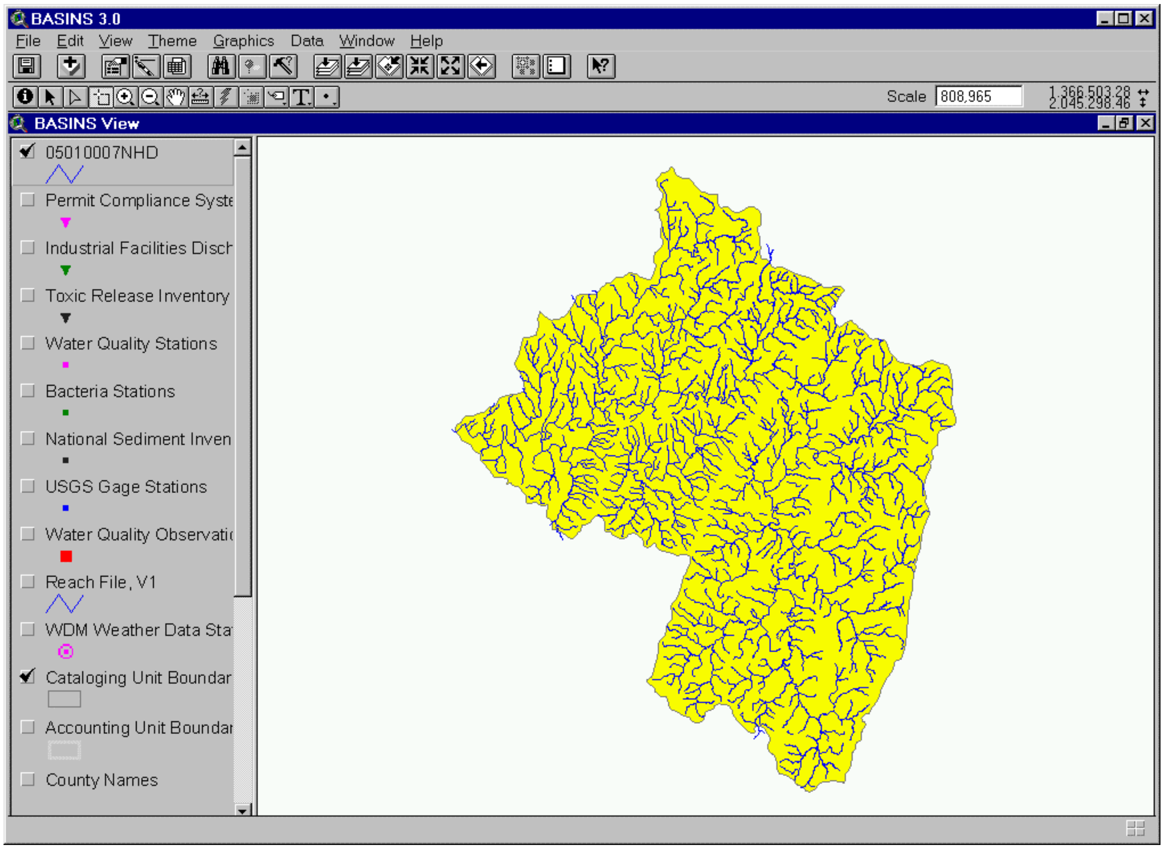
Screen 7.3.8

12. Select a View to add the theme in and click *OK* (Screen 7.3.9).



Screen 7.3.9

13. A NHD theme will be added to the selected view. The default name of the theme is the cataloging number with NHD at the end (eg. 05010007NHD). Select the theme and make it active. (Screen 7.3.10)


BASINS 3.0
File Edit View Theme Graphics Data Window Help
Scale 808,965
BASINS View
05010007NHD
Permit Compliance Syste
Industrial Facilities Disch
Toxic Release Inventory
Water Quality Stations
Bacteria Stations
National Sediment Inven
USGS Gage Stations
Water Quality Observatic
Reach File, V1
WDM Weather Data Sta
Cataloging Unit Boundar
Accounting Unit Boundar
County Names
Screen 7.3.10

7.4 Grid Projector

Purpose

Grid Projector is a tool for conversion of ArcView/ArcInfo grid data between two map projections in ArcView environment. This is based on the projection conversion tool PROJ (Evenden, 1995). Grid Projector has capability for forward and inverse projection to and from a geographic reference (latitude-longitude) to several cartesian coordinates (feet, meters, etc.,). The supported Projections in Grid Projector are as follows:

1. Geographic Projection
2. Cylindrical Projections
    a. Mercator
    b. Transverse Mercator
    c. Universal Transverse Mercator (UTM)
    d. Oblique Mercator
    e. Miller
    f. Equal Area Cylindrical
    g. Equidistant Cylindrical
    h. Cassini
3. Pseudocylindrical Projections
    a. Sinusoidal
    b. Mollweide
    c. Robinson
4. Conic Projections
    a. Albers Equal Area
    b. Lambert Conformal Conic
    c. Equidistant Conic
5. Azimuthal Projections
    a. Stereographic

   b. Gnomonic
   c. Orthographic
   d. Near-Sided Perspective
   e. Lambert Azimuthal Equal Area
   f. Azimuthal Equidistant
   g. Hammer
6. Miscellaneous Projections
   a. New Zealand Map Grid
7. State Plane Coordinate System (SPCS)

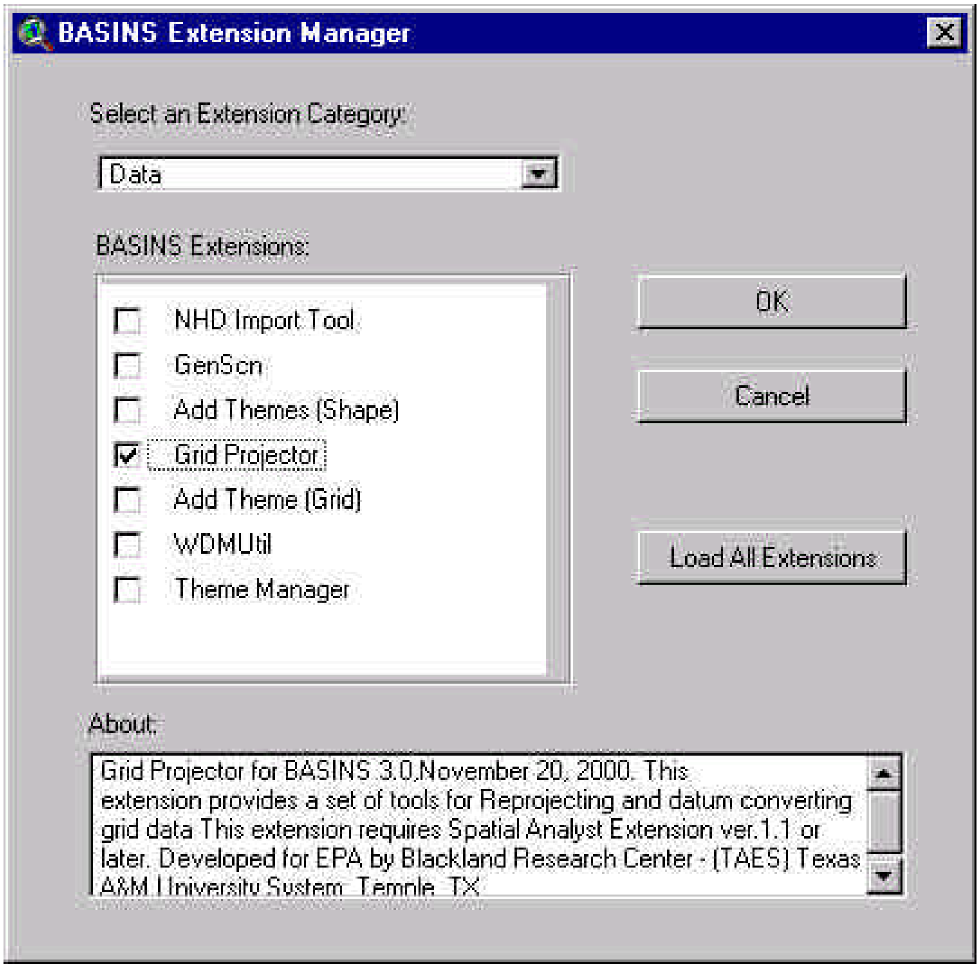
Application

Projection of a grid involves a three-step procedure. The input grid boundary coordinates are projected to determine a list of coordinates in the output grid. Each of these coordinates are re-projected to the source grid projection and interpolated to identify a corresponding cell location in the source grid. The values from the source cells are then copied to the output grid.

ArcView GRID IO functions are used for reading and writing the grid. Nearest neighborhood method is used as a default interpolation method. Other interpolation options are not included at this time. Currently the projector supports datum conversion of grids between the North American Datums (NAD27 and NAD83). For other datum formats, both the input and output grids are assumed to be in the same datum. Input and output grid with coordinate units in meter, feet, decimal degree (only for geographic), mile and kilometer can be used with this projector.

Before you Get Started

First, verify that the Grid Projector extension is active in your BASINS project by typing Ctrl+B from the BASINS View (or selecting the BASINS Extension choice in the File Menu) and selecting the Data Manager item from the Extension Categories dropdown list. The Grid Projector entry in the Basins Extensions list should be visible and selected (Screen 7.4.1).

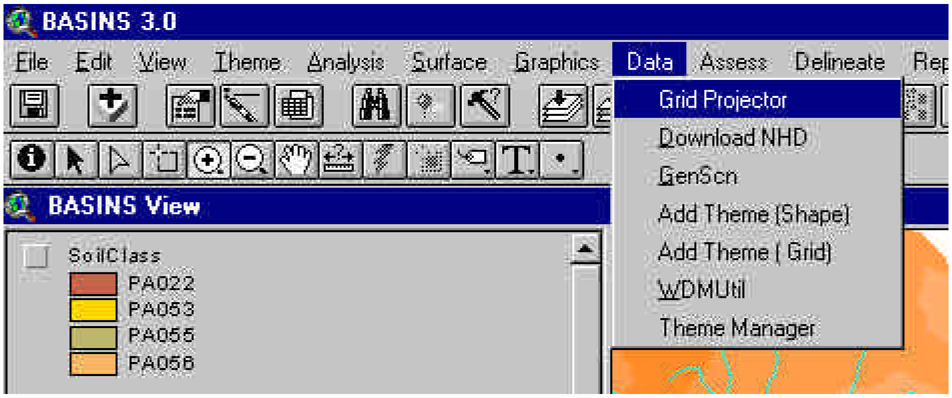


Screen 7.4.1

If the Grid Projector entry is not selected (checked), click on it to select it.

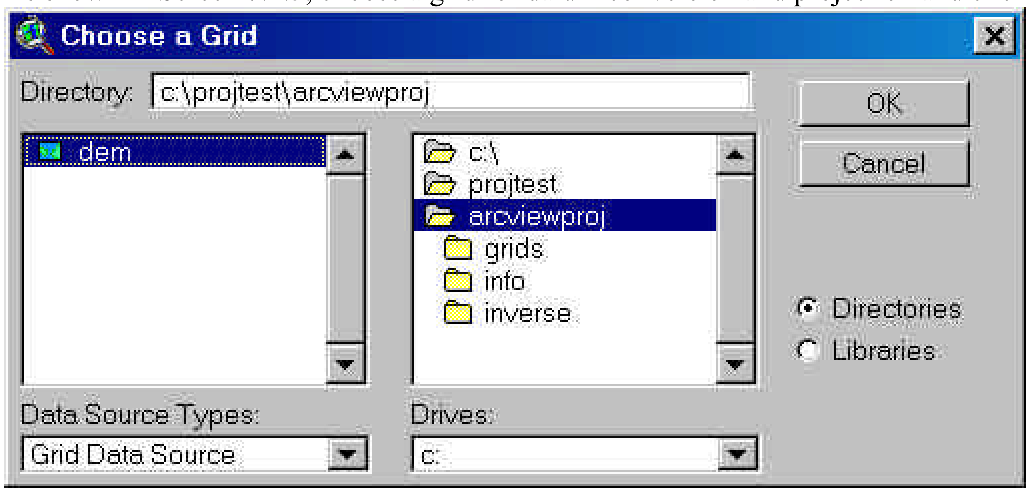
Steps in Running the Grid Projector

1. Select the menu choice Grid Projector, from the BASINS View menu Data, to start the grid projector tool (Screen 7.4.2).



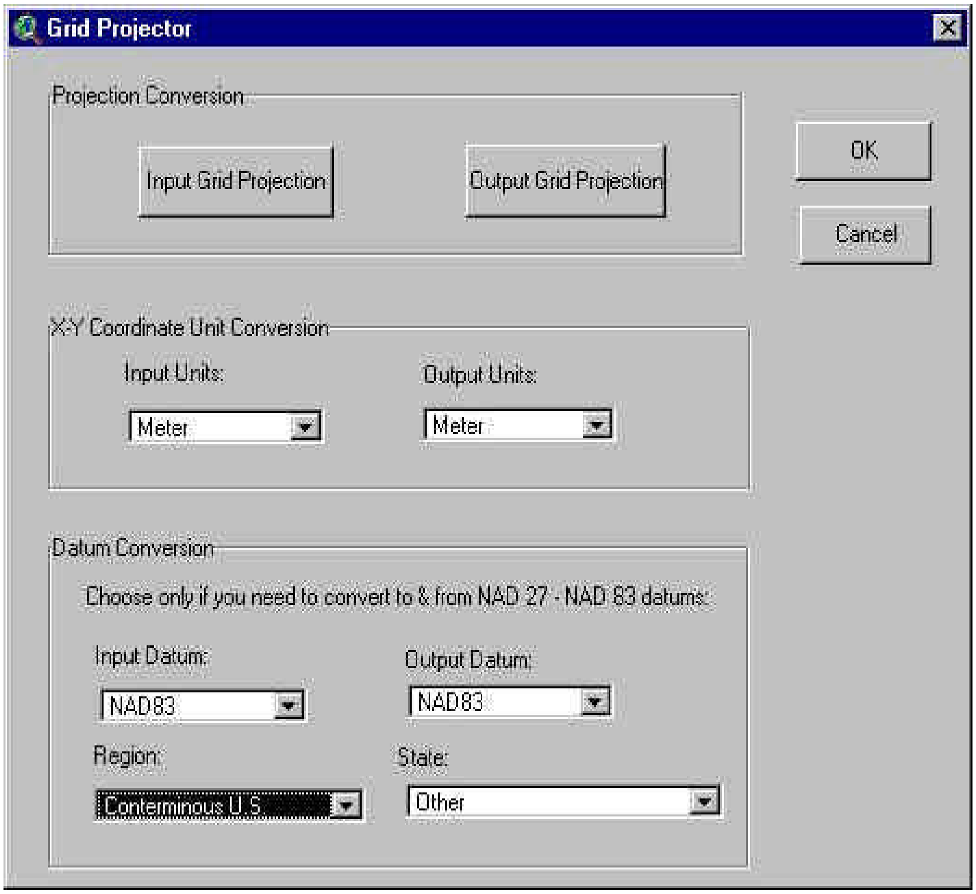
Screen 7.4.2

2. As shown in Screen 7.4.3, choose a grid for datum conversion and projection and click OK.

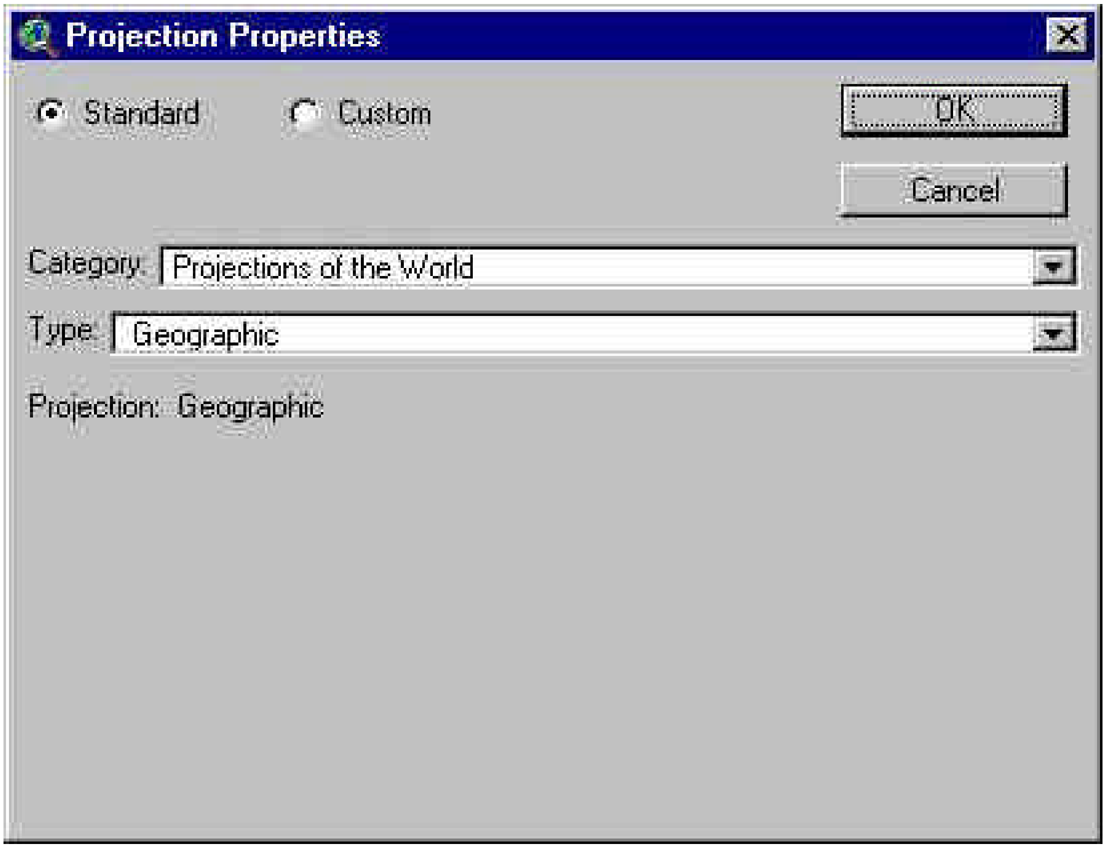


Screen 7.4.3

3. Input the information required for projection, datum conversion and coordinate unit conversion in the grid projector dialog (Screen 7.4.4). Click on the Input Grid Projection button to enter the input grid projection information in the projection dialog (Screen 7.4.5). The projection dialog has Custom and Standard options for entering the projection information. The custom option has predefined projection parameters for projection systems such as Universal Transverse Mercator (UTM), State Plane Coordinate System (SPCS) and U.S. Albers Equal Area Projection. The Standard option allows the user to input the projection parameters. Click on the Output Grid Projection button to input the output grid projection information and follow the same procedure as described for input grid.


Grid Projector
Projection Conversion
Input Grid Projection
Output Grid Projection
OK
Cancel
X-Y Coordinate Unit Conversion
Input Units:
Meter
Output Units:
Meter
Datum Conversion
Choose only if you need to convert to & from NAD 27 - NAD 83 datums:
Input Datum:
NAD83
Output Datum:
NAD83
Region:
Conterminous U.S.
State:
Other

Screen 7.4.4



Screen 7.4.5

The grid projector supports grid coordinate units in meter, feet, miles and kilometer for non-geographic projections. For geographic coordinates Decimal Degree is the only unit which is supported at this time. Choose the desired input and output grid units for conversion in the Units Conversion part of grid projector dialog.

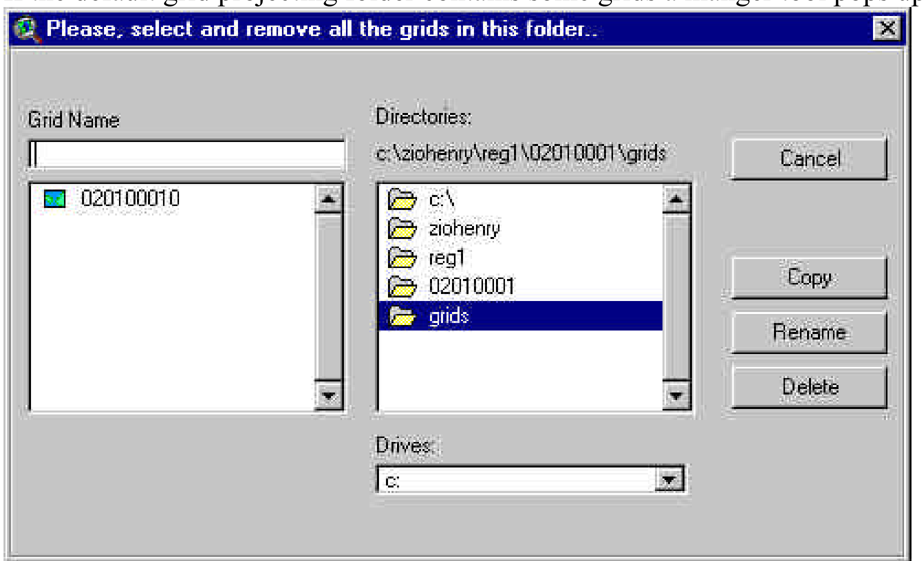
Currently the conversion between the North American Datums NAD27 and NAD83 is supported in this tool. Choose the input, output datum, region and state information only if the datum conversion is needed. If no datum conversion is needed or if a grid is in a different datum than NAD27 or NAD83 you don not have to make any selection in the datum conversion part of the dialog.

For the purposes of datum conversion, the U.S is divided into 7 major regions, for which the datum reference files are available. Select the appropriate region in the "REGION" list. For some of the states in the conterminous U.S. high precision GPS data are available. Identify the state if it is listed in the list "STATE". Choose "other" if a state is not available in this list.

4. Change the value for the Buffer (number of cells) if in the resulting projected grid part of the data cells are cut off. The default value of 100 is a reasonable value that is enough for most of the US regions and usual projections. Be carefull using Buffer values higher than 500, since the disk used will rapidly increase.

5. If you wish the projected grid added to a View check the respective *Add Projected Grid to a View* box. This option is highly recommended since the projected grid will be immediately displayed and without the No Data values.

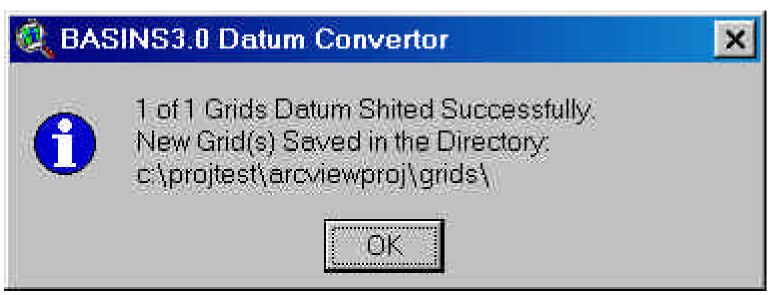
6. If the default grid projecting folder contains some grids a manger tool pops up (Screen 7.4.6).



Screen 7.4.6

Select and Delete all the grids in the current folder and click Cancel.

7. Based on the size of the grid, it might take few minutes to several hours to complete the projection. If the grids are projected/datum converted successfully a message similar to the dialog given here will appear.



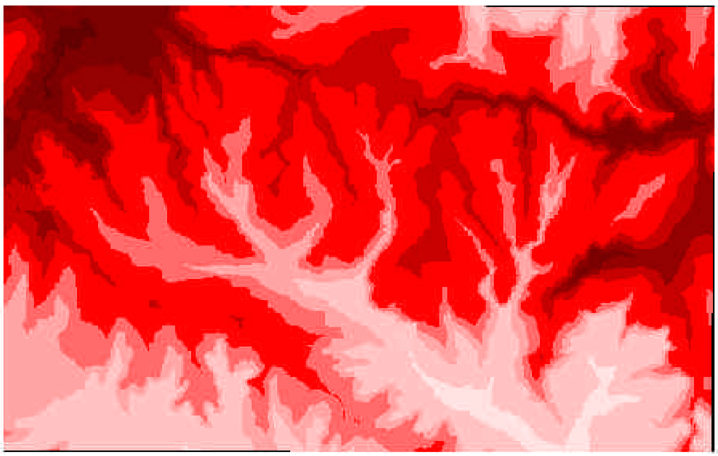
Screen 7.4.7

It takes twice the amount if the input or output grid is not in geographic coordinates. It took about 1 hour and 5 minutes for projecting a grid with approximately 16000 x 17000 cells from geographic to Albers equal area projection, in PC running Windows 98 with 500 MHz PIII processor and 128 MB RAM. The projected/datum converted grid(s) are saved in a directory GRIDS under the data directory.

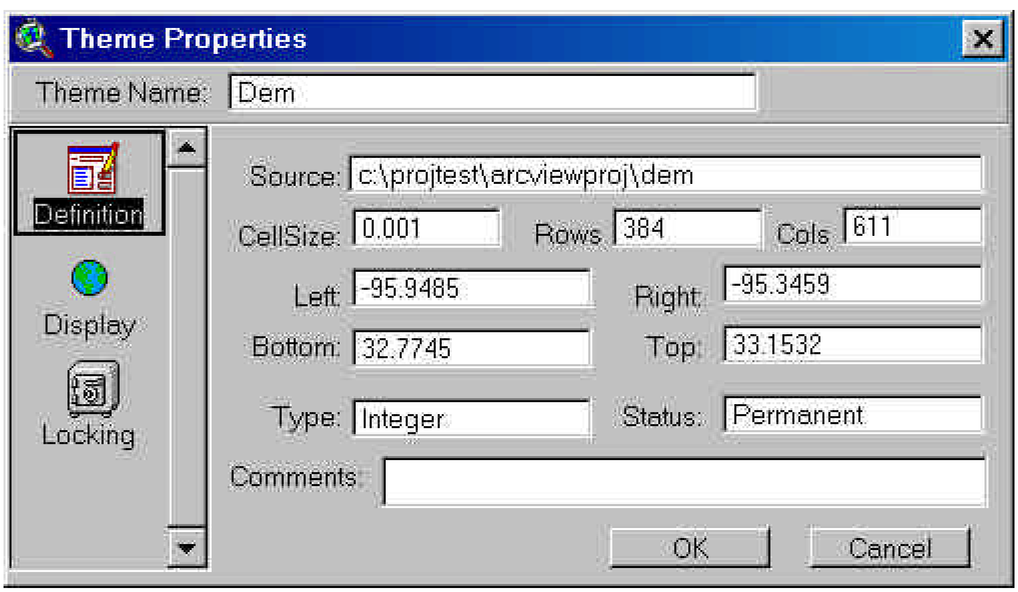
Example Applications of Grid Projector

I. Conversion from Geographic to Albers Equal Area Projection (AEA)

In this example a grid of size 384 x 611 cells represented in lat-lon coordinates will be converted to AEA projection. The two images given below show the grid and its properties.



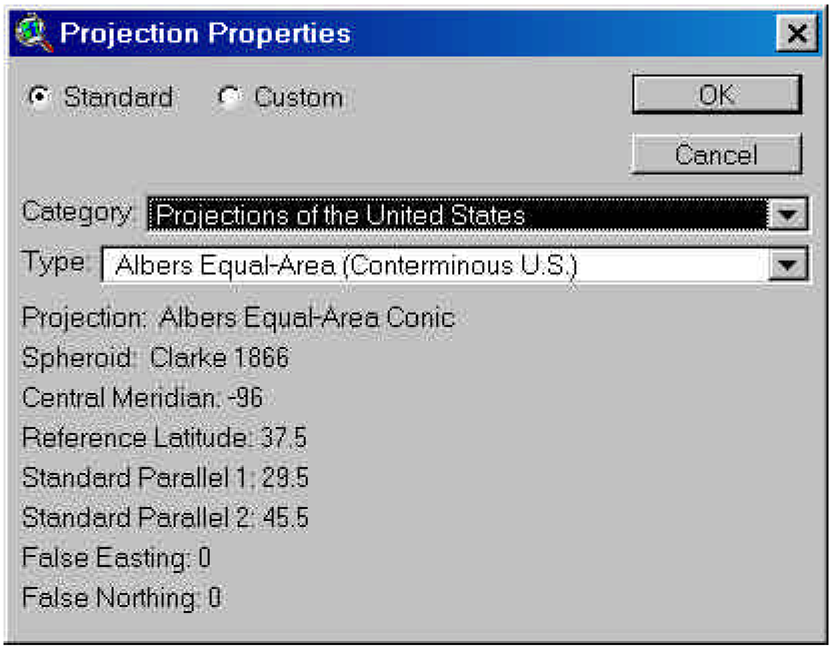
Screen 7.4.8



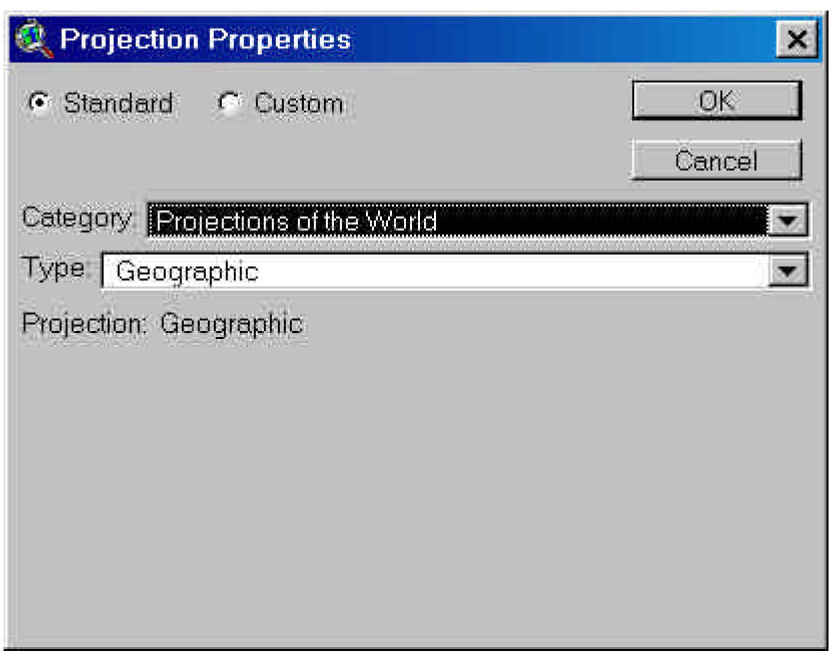
Screen 7.4.9

The grid projector project was opened and the grid to be projected was selected.

Using the grid projector dialog, the input and output grid projection parameters for were selected. In the projection dialog, GEOGRAPHIC projection is the default projection. Since the input grid is in GEOGRAPHIC format, the default was accepted by clicking OK. Projection parameters for the Albers Equal Area Projection, for the Conterminous US, Alaska, and Hawaii the parameters are predefined under the “category” Projections of the United States. Since the example grid is located in Texas, the “type” of AEA was identified as AEA for Conterminous U.S. For using AEA for the grid located outside the U.S, the custom option can be used for input of projection parameters.



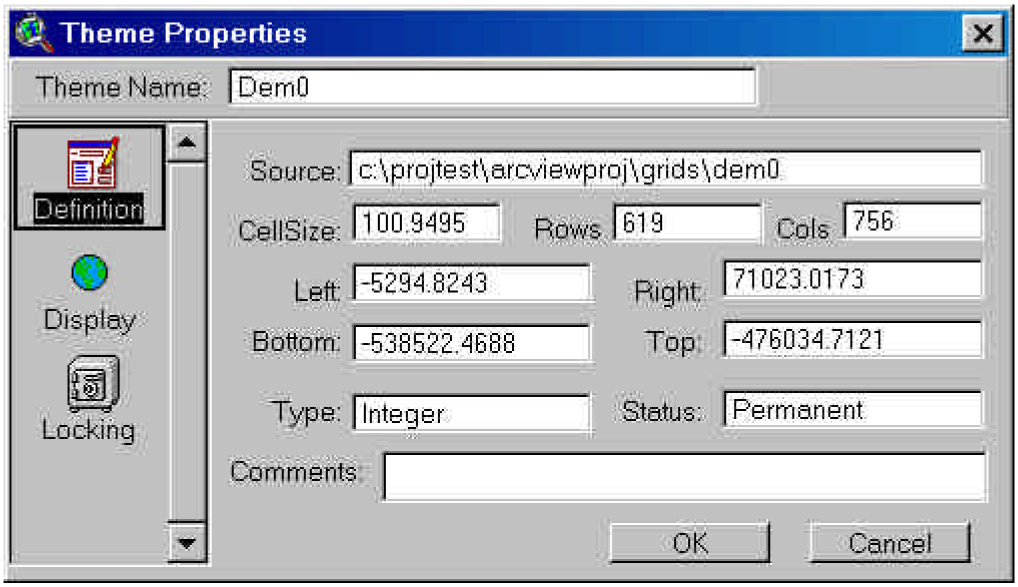
Screen 7.4.10 - Albers Equal Area Projection



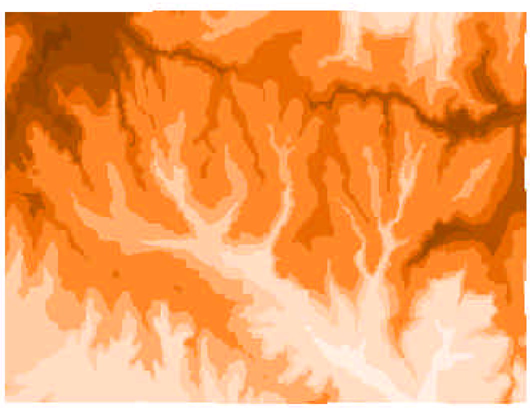
Screen 7.4.11 - Geographic Projection

“Meter” was chosen as the desired unit for the output grid. Since no datum conversion was to be performed, no selection was made in the datum conversion part of the grid projector dialog.

The projected grid and its parameters are given in the figure below. Please note the cell size and number of rows and columns in the output grid are different from that of the input grid. The output grid is saved in a directory GRIDS under the input grid directory.



Screen 7.4.12 - Projected Grid Properties

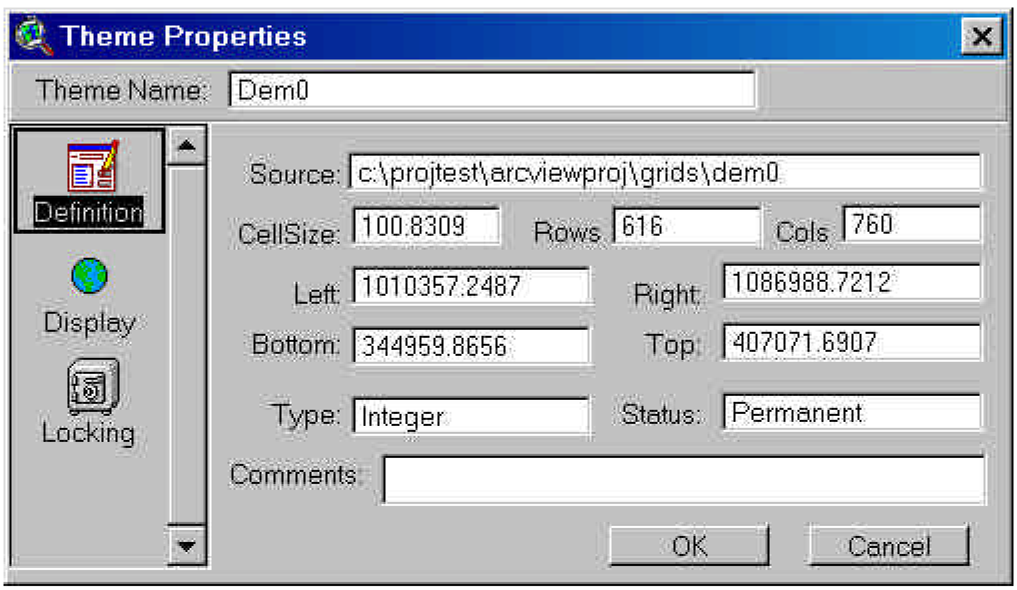


Screen 7.4.13 - Projected Grid

II. Conversion from SPCS’27 to UTM’83

The grid used in the previous example was converted from State Plane Coordinate System of 1927 to Universal Transverse Mercator System of 1983.

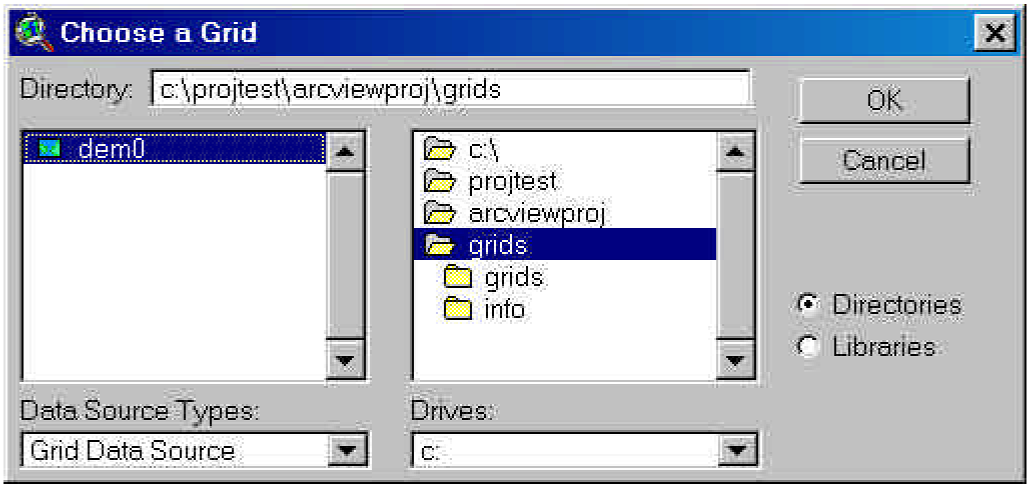
Screen 7.4.14 - Input Grid (SPCS'27)



Screen 7.4.15 - Input Grid Properties

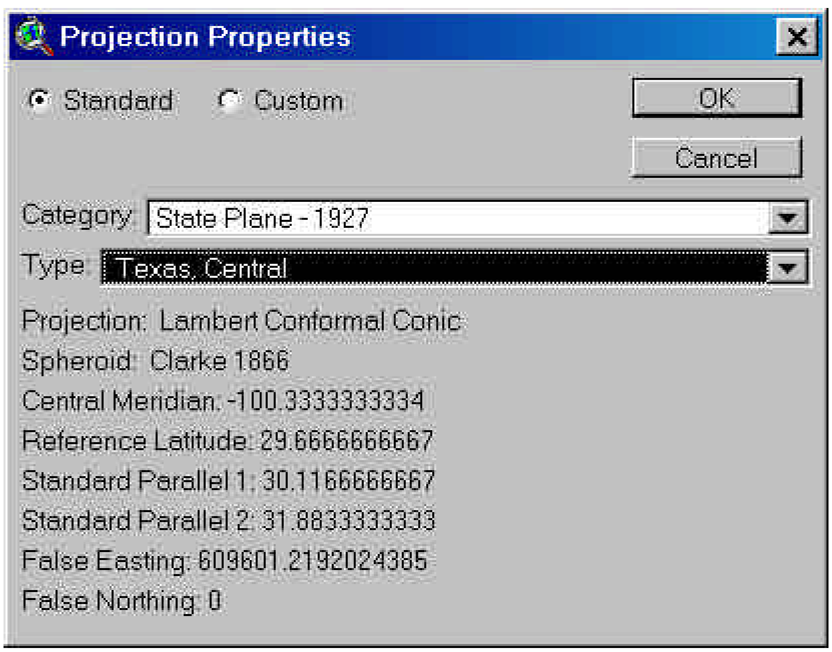
The above figures show the input grid in SPCS'27 and its properties. The state plane zone of this grid was central Texas.

In the next step the grid to be projected was identified.



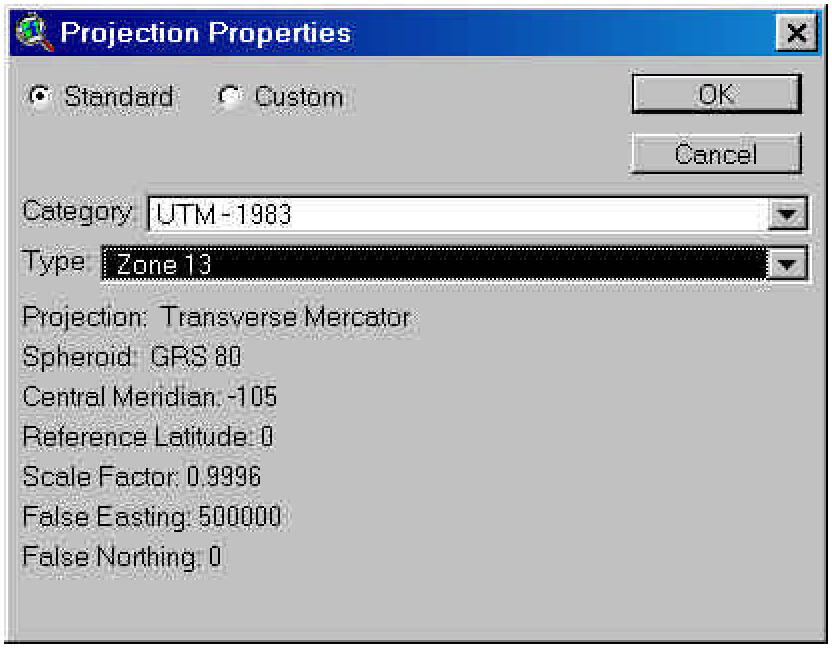
Screen 7.4.16 - Grid to Project

Using the grid projector dialog the projection and datum conversion parameters were selected. The input projection information was input in the projection dialog. Since the SPCS is predefined in the projection dialog (under STANDARD option), only the SPCS zone of the grid was to be identified.



Screen 7.4.17 - Input Grid Projection Properties

The input grid unit (meters in this example) was selected after this step. As the output projection properties (UTM'83) is also predefined in the projection dialog, only the UTM-zone was required input. As the grid to be projected was within UTM zone 13, this zone was identified. In the next step "meter" was chosen as the desired output unit.

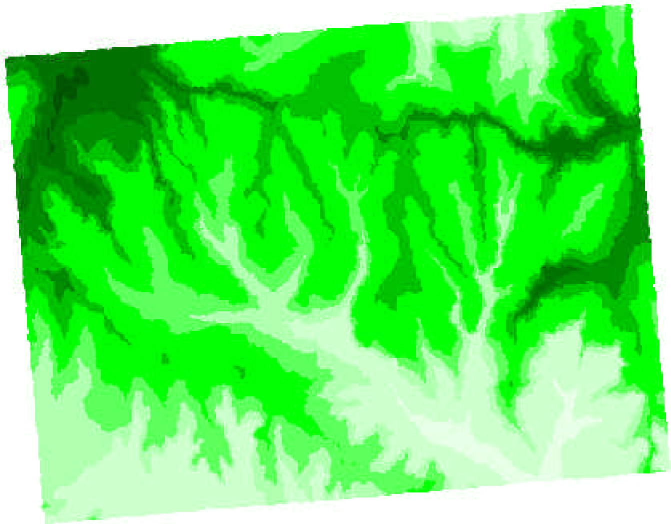


Screen 7.4.18 - Output Grid Projection Properties

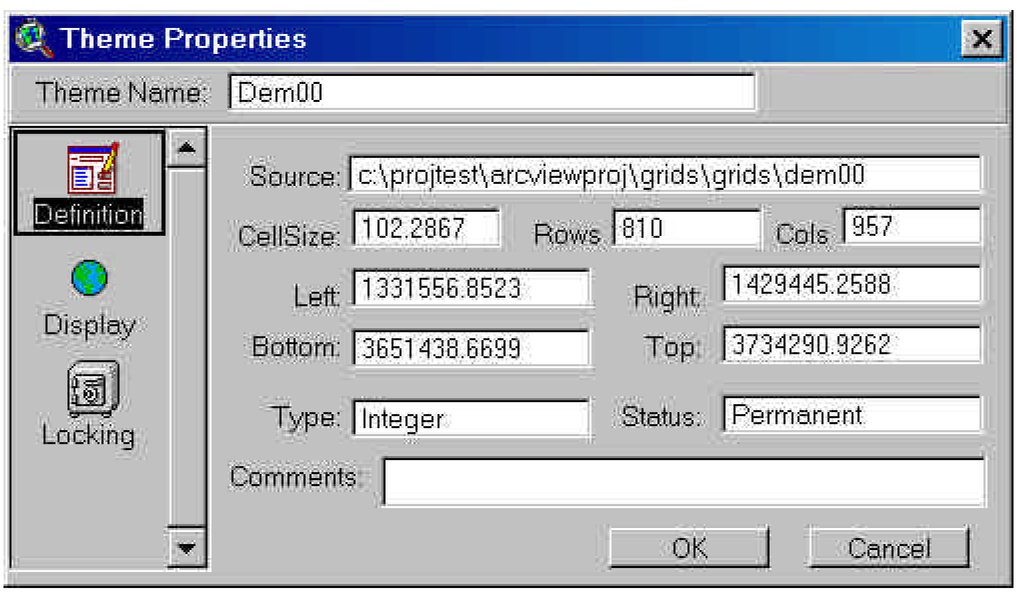
Since the grid location is in central Texas, the region falls under Conterminous US. High precision GPS data was also available and this appropriate location (Texas-East of 100 degrees) was selected in the STATE option. The input and output datum was chosen as NAD27 and NAD83 respectively.

In the following step, the location (directory) of the datum conversion reference file (the High Precision GPS data) was identified. The directory (named "nadfiles" in this example) contains a file named ethpgn.txt which has the GPS reference data for the east Texas region

The projected grid and its properties are shown below. Since a buffer of 100 cells is added to the grid during projection, the number of grid rows and columns in the output grid is considerably higher than the input grid.



Screen 7.4.19 - Projected Grid



Screen 7.4.20 -Projected Grid Properties

Choosing a Map Projection

According to Cox (1996), the choice of a suitable map projection depends on the purpose of the project, the size, and shape and the location of area of interest. The following table provides general criteria for choosing a map projection:

Projection	Suitability
Normal Cylindrical	Equatorial regions with east-west extent
Transverse Cylindrical Projections	Region with predominant north-south extent
Conic Projections	Mid-latitudes
Azimuthal Projections	Polar regions
Equal-Area Projections	Useful for statistical studies, thematic maps
Conformal Projections	Preserve angular relationship. Suitable for presentation maps
Mercator Projections	Navigational Maps

For representation of earth's surface on a map four parameters are required in common for most of the projections.

1. Central Meridian - longitude
2. Central Parallel - latitude
3. False Easting – x shift
4. False Northing – y shift

The central meridian is a representation of longitude that is used to center a projection. The central parallel is a representation of the latitude which, unless and other wise specified is assumed to be equal to zero. The false easting and false northing (also known as cartesian offsets) are optional parameters.

Spheroid/Ellipsoid

The earth is considered to be a sphere for most of the applications, especially for small-scale maps (less than 1:5,000,000). The radius of the earth can be used to accurately describe the sphere. However, due to the rotation, the earth is slightly flattened on the poles and can be better represented by an ellipsoid (or spheroid) of rotation about the polar axis. The two parameters required for describing the ellipsoid are its semi-major axis and semi-minor axis.

In the Grid Projector, the Clarke 1866 ellipsoid is considered to be the default ellipsoid. The projector supports grids which are represented in any of the following eleven ellipsoids.

1. Airy 1830
2. Australian National
3. Bessel 1841
4. Clarke 1866

5. Clarke 1880
6. Everest 1830
7. GRS 80
8. International 1909 (Hayford)
9. Krasovsky
10. WGS 72
11. WGS 84

Projections

Geographic Projection

Although mentioned here as a projection, Geographic is not a projection by itself. It is linear representation of a surface as a spherical reference grid using latitude, longitude coordinates. The general units of representation are Degrees Minutes Seconds (DMS), Decimal Degrees (DD), Decimal Minutes (DM) or Decimal Seconds (DS). The grid projector requires the input grid to be in DD units.

Cylindrical Projections

Mercator Projection

The surface of projection is represented by equally spaced vertical parallels (longitudes), and horizontal parallels (secant of latitude) which are increasingly spaced towards the pole. This projection is suitable for conformal maps of equatorial regions. The parameters required for this projection are:

1. Central Meridian
2. Latitude of true scale
3. False easting
4. False northing

Alias: Wright Projection

Transverse Mercator Projection

The Transverse Mercator projection is also a conformal projection like the mercator projection. In this the equator of the projection is rotated 90? to provide a constant scale along any central meridian. This projection is suitable for regions with predominant north-south orientation. It is used in the SPCS for some states in the U.S. The parameters required for using this projection are: Central Meridian Reference Latitude Scale Factor False Easting False Northing

Aliases: Gauss Conformal, Gauss-Krüger (both ellipsoidal), Transverse Cylindrical Orthomorphic

Universal Transverse Mercator Projection (UTM)

The UTM is a ellipsoidal transverse mercator projection originally adopted by the U.S. Army for military maps of the world. The earth (between 84?N and 80?S) is divided into 60 zones spaced at 6? of longitude. Each zone has a unique central meridian. All the parameters required for using this projection are pre-defined in the projection dialog. The user has to select the UTM zone of the input/grid to use this projection.

Oblique Mercator Projection

The Oblique Mercator Projection is a modification of mercator projection, suitable for application in areas that have large areas in oblique orientation (not north- south or east-west). In the United States, this projection is used in the SPCS for mapping the panhandle of Alaska. The parameters required for usage of this projection are: Longitude of central point Latitude of central point Azimuth of central line Scale factor along the central line False easting False northing *Alias: Hotine Oblique Mercator*

Miller Projection

Similar to the Mercator projection, the meridians are parallel and equally spaced. The longitudes are parallel but the lines are increasingly spaced towards the poles. By reducing the distance between the lines of latitude towards the pole by a factor of 0.8, the distortion in polar regions are minimized. This projection is available only is spherical form. The central meridian in the only parameter required for using this projection.

Cylindrical Equal Area Projection

Similar to a regular cylindrical projection, equal-area projection consists of straight equally spaced meridians and unequally spaced parallels. Based on the latitude selected for standard parallel several projections have been defined for cylindrical equal area projection. The Lambert's form uses a standard parallel of 0º. The Gall's orthographic and Behrmann's projection use the values 45º and 30º respectively. The parameters required for usage of this projection are: Central Meridian Standard Parallel *Aliases: Lambert-cylindrical equal area, Behrmann, Gall Orthographic, Peters*

Equidistant Cylindrical Projection

This projection represents a surface as grid by linear scaling of latitudes and longitudes. The meridians and parallels are straight lines. Plate Carrée projection is a form of equidistant cylindrical projection where the equator is used as a central meridian. However any line can be used a central meridian with the equidistant cylindrical projection. The parameters required for usage of this projection are: Central Meridian Reference Latitude

Cassini Projection

The meridians and parallels are represented by complex curves instead of straight lines in Cassini projection. The central meridian and equator are straight lines. The central meridian is equally spaced at 90º. The parameters required for the usage of this projection are: Central Meridian Reference Latitude *Alias: Cassini-Soldner Projection*

Pseudocylindircal Projections

The pseudocylindrical projections have horizontal straight lines for parallels of latitude and curved lines for the meridians. Sinusoidal Projection

The Sinusoidal projection is the oldest pseudocylidrical projection that is still is use. The projection has equally spaced straight parallel lines of latitude intersecting the central meridian (also a straight line) perpendicularly. All the other meridians are sinusoidal curves. The central meridian is the only parameter required for using this projection.
Aliases: Sanson-Flamsteed, Mercator-Equal Area

Mollweide Projection

The Mollweide projection has only two points that are free of distortion. Because of this it is often used for very large area map or the world map projection. The parallels are unequally spaced straight lines with the meridians being equally spaced elliptical arcs. The central meridian is the only parameter required for using this projection. Aliases: Homolographic, Homalographic, Babinet, Elliptical

Robinson Projection

This is a modified cylindrical projection with straight central meridians and parallels. Other meridians are curved. Similar to Mollweide projection it is used for world map projections and the central meridian is the only parameter required for using this projection.
Alias: Orthophonic Projection

Conic Projections

In a basic conic projection, assuming a cone placed on top of the earth, the parallels are represented by arcs of concentric circles and the meridians represented as equally spaced radii of these circles. The spacing between the parallels vary based on the type of projection. Albers Equal Area Conic Projection

This is the most commonly used projection for conterminous United States maps. The projection consists of unequally spaced concentric arcs of circles as parallels and equally spaced radii as meridians. The parameters required for usage of this projection are: Central Meridian Reference Latitude Standard Parallels 1 & 2 False easting False northing These projection parameters are predefined in the projection dialog for projecting maps of conterminous US, Alaska, Hawaii and North America.

Lambert Conformal Conic Projection

The Lambert conformal conic projection is not an equal area projection, like Albers. It has arcs of circles originating from a common point as parallels. The meridians are equally spaced radii for these parallels. It is suitable for regions with predominant east-west orientation. The parameters required for usage of this projection are: Central Meridian Reference latitude Standard Parallels 1 & 2 False easting False northing

Equidistant Conic Projection

The equidistant conic projection is one of the simplest conic projections. It is neither conformal nor a equal area projection but a compromise between these two forms of projections. Unlike the normal conic projections, the parallels on equidistant conic are almost equally spaced on both spherical and ellipsoidal versions. The meridians are equally spaced as in the other conic projections. The parameters required for usage of this projection are: Central Meridian Reference latitude Standard Parallels 1 & 2

Azimuthal Projections

Azimuthal projections are representation of a surface on a plane that is tangential to either of the poles, the equator, or any point on the surface of the earth. These three aspects are called the polar, the equatorial and the oblique aspects. This projection is popular for accurate representation of distance and direction in maps. Stereographic Projection

This is conformal projection mainly used in the maps of polar region. In the polar or equatorial aspect, all the meridians are straight lines and the parallels are arcs of circles. It has a central meridian and a parallel as straight lines. All other meridians and parallels are represented as arc of circle. The projection is accurate in representation of direction in its spherical form. The parameters required for usage of this projection are: Central Meridian Reference Latitude

Gnomonic Projection

The Gnomonic projection is a true perspective projection from the center of the earth to a plane tangent to its surface. All the meridians and equators are straight lines. All parallels, except the equator and poles are ellipses, parabolas or hyperbolas. As the great-circle arc, which represents the shortest distance between two points on the globe, lies in a plane passing through center of earth, the Gnomonic projection is useful for navigational maps. The parameters required for using this projection are: Central Meridian Reference Latitude

Orthographic Projection

It is the most commonly used Azimuthal projection. As the point of perspective for this projection in the planar aspect is at an infinite distance, it is often used for projecting the view of earth from space. Only one hemisphere can be viewed at any time. The central meridian and reference latitude are required for usage of this projection.

Lambert Azimuthal Equal Area Projection

It is an non-perspective equal-area projection, best suited for projections of land mass such as continents and hemispheres. All meridians in polar aspect, equator in the equatorial aspect and central meridian in other aspect are straight lines. All other meridians and parallels are complex curves. Similar to other Azimuthal projections, the central meridian and reference latitude is required for using this projection.

Azimuthal Equidistant Projection

This is neither a equal-area nor a conformal projection. One important feature of this projection is that the distance measured from a central point is true. Drawing a circle from the central point can identify locations of equal distance from the center. This is used commonly used with polar aspect for world maps and in maps of polar hemispheres. Similar to other Azimuthal projections, the central meridian and reference latitude is required for using this projection.

Vertical Near-Sided Perspective Projection

Similar to the Orthographic projection, Vertical Near-Sided Perspective projection is a perspective from space. Unlike the infinite distance of point of perspective in the Orthographic projection, the user can specify the distance in this case. The parameters required for this projection are central meridian, reference latitude and height of view point.

Hammer –Aitoff Projection

It is an equal-area projection where all meridians in polar aspect, the central meridian in other aspects and the equator in the equatorial aspect are straight lines. All other meridians are either circles or complex curves. Unlike other Azimuthal projections, this is not a perspective projection. The central meridian is the only parameter required for using this projection. Inverse projection (Hammer to Geographic or other projections) is not allowed.

Miscellaneous Projections New Zealand Map Grid

The land mass of New Zealand can be projected using this projection. The central meridian and parallel are fixed at 173º E and 41º S respectively. The International ellipse is also a fixed shape for the projection. False easting and northing are fixed at 2,510,000 and 6,023,150 m respectively.

State Plane Coordinate System (SPCS)

Although this is not a projection by itself, it is listed separately for emphasizing its use in the United States. SPCS27 and SPCS 83 are the two SPCS coordinate systems commonly used. In SPCS27 North American Datum of 1927 (NAD27) and Clarke 1866 ellipsoid is used as a Standard. In SPCS83, NAD83 datum and GRS80 ellipsoid are used as standards. Transverse Mercator projection is adopted as a standard in SPCS for states with predominant North-South extent. For the panhandle of Alaska, the oblique mercator projection is used. For the remaining states Lambert Conformal Conic is adopted as a standard projection. All the projection parameters requires for using the SPCS are predefined in the projection dialog. The user has to choose the appropriate SPCS (SPCS 27 or 83) and the corresponding SPCS zone.

References:

Cox, S. J. D. 1996. r.proj: A Program to Cartographically Reproject Raster Maps for Use with GRASS GIS. AGCRC, CSIRO Exploration & Mining Report 238F.

ESRI. 1994. Map Projections- Georeferencing Spatial Data, Environmental Systems Research Insitute Inc., CA

Evenden, G. I. 1990. Cartographic Projection Procedures for the UNIX Environment – A User’s Manual. U.S. Department of Interior Geological Survey. Open File Report 90-284.

Snyder, J.P. 1987. Map Projections – A Working Manual. U.S. Geological Survey Professional Paper 1395.

7.5 GenScn

BASINS includes the program *GenScn*, originally developed by the U.S. Geological Survey, which facilitates the display and interpretation of output data derived from model applications. GenScn is not a model itself. It serves as a postprocessor for both the HSPF and SWAT models, as well as a tool for visualizing observed water quality data and other timeseries data. GenScn allows users to select locations and time periods within the subject watershed area and to create tables and graphs based upon these selections.

GenScn can process a variety of data formats, including *HSPF* simulation output, BASINS water quality observation data, and USGS flow data, and SWAT output data. It also performs statistical functions and data comparisons. Due to its ability to display and compare observed and modeled data, the postprocessor is a useful tool in model calibration and environmental systems analysis. See the GenScn User's Manual for instructions on using GenScn.

BASINS contains an extension that allows the user to open GenScn directly from the BASINS user interface. See the Basins Components - Extension Manager section for instructions on activating this extension. Alternatively, the GenScn Extension User's Manual contains more detailed information on using the extension.

7.6 WDMUtil

HSPF uses Watershed Data Management (WDM) files, which contain input and output timeseries data, in order to run. BASINS includes the program *WDMUtil*, which is a utility program for managing such files. See the WDMUtil User's Manual for instructions on using WDMUtil.

BASINS contains an extension that allows the user to open WDMUtil directly from the BASINS user interface. See the WDMUtil Extension User's Manual for instructions on using this extension.